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THOMAS AVELING.

It is with a sorrow which will be shared by a large number of our readers in many countries that we have to announce the death of Mr. Thomas Aveling, head of the firm of Aveling & Porter, engineers, Rochester, Eng. Mr. Aveling, who was but fifty-seven years of age, was in his usual health until about ten days since, when, while yachting, he caught a chill which settled on his lungs, producing acute inflammation, and he died on Tuesday, 7th March, 1882.

Descendant of a good old Cambridgeshire family, he, the eldest of three sons, was born at Elm, near Wisbeach, September 11, 1824. Mr. Aveling was the first to introduce the steam plow into Kent, in acknowledgment of which the farmers of the county presented him with a piece of plate and a purse containing three hundred guineas. Soon after his marriage his father in-law and he entered into business as constructors and repairers of farm machinery, and having taken the old-established foundry known as Thomas's, Strood, they proceeded to construct traction engines on the pitch chain principle, which was an early patent of Mr. Aveling's. With one of these engines Mr. Aveling took the first prize of the Royal Agricultural Society of England at their show at Battersea in 1860, and from that time to the present the progress of the firm has been one of continued success.

About this time it became obvious that if the firm were to supply the demand which began to exist for traction engines the works must be placed on a new footing. It was at this period that Mr. Porter joined the firm, who added to Mr. Aveling's practical and theoretical skill a sound knowledge of business, which has contributed so largely to the success and high repute of the firm.

From the time when Mr. Aveling constructed his first traction engine he always aimed at simplicity and strength, and it was his rigid adherence to these two points which has made him "the father of traction engines" quite as much as George Stephenson was of the locomotive. Many persons had made traction engines for drawing loads previously, but from their weakness and their complication few gave satisfactory results. The proof of the excellence of Mr. Aveling's design, which, of course, has been subject to many modifications as improved material, machine tools, and labor have been available—lies in the fact, that those makers construct the best engines who follow most closely the types adopted by Mr Aveling. Of the honors conferred on Mr. Aveling by the leading agricultural societies, both in this country and abroad, as well as by the Commissioners of International Exhibitions, it is unnecessary to speak. By the invention and introduction of steam rollers, in which Mr. Aveling was fortunate in securing the services of his cousin, Mr. Stephen Aveling, our roadways have been improved in a way which few persons can believe, unless they compare the condition of a well-rolled macadamized road with an unrolled or improperly rolled one under similar conditions of traffic.

Steam road rollers may be said to have literally paved the way for wood pavement, for it was only from educating people up to the advantages of a good road that the desire for wood pavement arose. And although wood pavement is displacing macadam in the principal thoroughfares of our large towns, we may hope to see the day when every country highway in England will be steam rolled; for the present barbarous practice of injuring horses and vehicles by allowing them to grind in road metal very imperfectly is unworthy of the nineteenth century, and is very bad economy.

Mr. Aveling was a member of the Institution of Civil Engineers, Chevalier of the Legion of Honor, and Knight of the Order of Francis Joseph. He filled the office of Mayor of Rochester, and during the period of his mayoralty he was instrumental in effecting many important public improvements to that town. Among others the Castle Gardens, which had been previously in private hands and inaccessible to the public, were hired by the Corporation, properly laid out and planted, and are now probably the most picturesque public gardens of their size in England. He was also mainly instrumental in the erection of the new Corn Exchange, the public baths, and Sir Joseph Williamson's school. Mr. Aveling was an excellent public speaker, as he always knew what he wished to say and said it. In the spring of 1880, when he spoke at the Institution of Civil Engineers of the bad condition of many of the so-called

THOMAS AVELING.

macadamized roads of London, he carried all his hearers with him.

As a master Mr. Aveling was kind and just. No better evidence on this point is needed than the fact that many of his men have been with him ever since he was in business, and changes among the men in the works were rare. His treatment of his pupils, of whom he only took a very limited number, is worthy of imitation by other firms; for instead of leaving them to their own devices out of working hours, as is generally the case, he made them welcome at his house at all times, thus making the pupils interested in the prosperity of the works, and producing an *esprit de corps* which is too often lacking. He leaves a wife, a son, and four daughters to mourn his loss.

The foregoing we find in the *Engineer*. Our portrait is from the *London Graphic*.

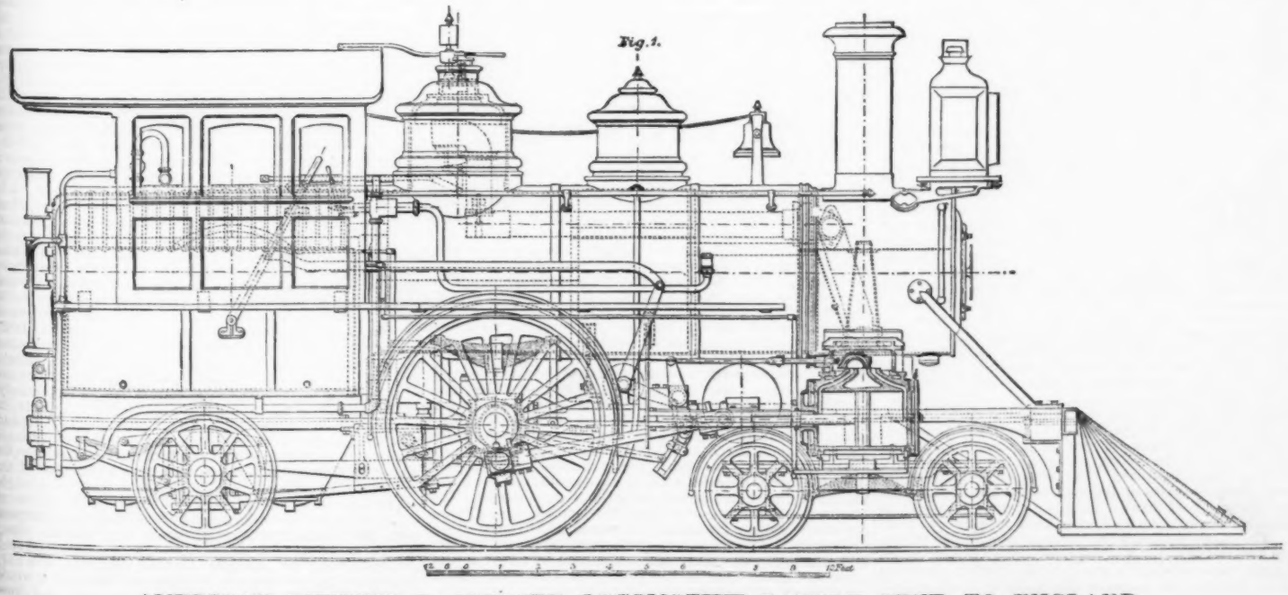
AMERICAN PASSENGER LOCOMOTIVE.

It was announced last year that the Eames Vacuum Brake Company had purchased, for importation into this country, an American passenger locomotive which had been constructed for performing an exceptionally quick service on the Philadelphia and Reading Railroad. We are somewhat at a loss to understand why the importation of the engine just referred to has been undertaken; but however this may be, the engine itself is one which possesses many features of interest, and as it was tried lately on the Lancashire and Yorkshire Railway, we have pleasure in laying engravings of it before our readers.

The engine is one designed and constructed by Messrs. Burnham, Parry, Williams & Co., of the Baldwin Locomotive Works, who have supplied us with the drawings from which our engravings have been prepared. It was, as we have already stated, originally built for the Philadelphia and Reading Railway Company, and it was intended to take trains from Jersey City to Philadelphia over the Bound Brook road—a distance of 89½ miles—in two hours. As will be seen from the engraving which we herewith present on this page, the engine has outside cylinders, and a single pair of drivers, there being a four wheeled truck at the leading end and a pair of trailing wheels under the fire box. The cylinders are 18 in. in diameter, with 24 in. stroke, and the diameter of the driving wheels being 6 ft. 6 in., the tractive force will be $\frac{18^2 \times 24}{78} = 99{\cdot}7$ lb. for each pound of effective pressure per square inch on the cylinders. The total weight of the engine in working order is 85,000 lb., of which 25,000 lb. rest on the front truck, and the remaining 60,000 lb. on the driving and trailing wheels. By means of the arrangement to be hereafter described, the distribution of this latter load can be varied from 35,000 lb. on the driving, and 25,000 lb. on the trailing wheels, to 45,000 lb. on the driving and 15,000 lb. on the trailing wheels, it being intended that the larger loads on the driving wheels should only be applied to give the engine the necessary adhesion to start a train promptly, or under exceptional conditions. The boiler pressure is 135 lb. per square inch, so that a cylinder pressure sufficient to give a tractive force equivalent to one-fourth the weight on the driving wheels can readily be attained.

The engine has a total wheel base of 21 ft. 1 in., while the distance between centers of driving and trailing wheels is 8 ft. All the wheels have cast iron centers and steel tires, while the respective diameters are as follows: Truck wheels 36 in., driving wheels 78 in., and trailing wheels 45 in. The wheels have solid spokes and hollow rims, and the driving tires are 3 in. thick. The axles are of wrought iron, the dimensions of the journals of the truck axles being 5 in. in diameter, by 8 in. long, those of the driving axle 8 in. in diameter by 9½ in. long, and those of the trailing axle 7½ in. in diameter by 8 in. long.

The truck is of the ordinary swing bolster pattern, with the springs arranged between beams which bear on the axle boxes, as shown. In the case of the driving axle the springs are directly above the axle boxes, the spring links at one end of each spring being coupled to the frame, while those at the other—or hind—end are coupled to a compensating beam. The trailing springs are somewhat curiously arranged, as will be seen on reference to the side elevation. They are placed in the rear of the axle, and the two ends of each spring are coupled to the frame as usual, while the center of each spring is connected to the rear end of a beam which passes over the corresponding trailing axle box (bearing on the latter), and has its front end coupled to the compensating beam already mentioned as being coupled to the driving



AMERICAN EXPRESS PASSENGER LOCOMOTIVE LATELY SENT TO ENGLAND.

spring. To the compensating beams are fitted the arrangement for varying the weight on the driving axle, to which reference has already been made. This arrangement is one designed and patented by Mr. W. P. Henszey, a member of the builder's firm, and it will be readily understood on reference to our side elevation. From this view it will be seen that each compensating beam has the usual fulcrum pin, taking a bearing on a bracket attached to the frame, this pin acting as the fulcrum under ordinary working conditions. When a heavier load is to be transferred to the driving axle, however, the bearing of the compensating beam is transferred from the ordinary fulcrum pin to a cam carried on the end of a short lever mounted on a transverse shaft, this cam being brought into action by partially turning the shaft. The turning of this shaft is effected by means of an arm on it, which is coupled to the rod of a piston working a vertical steam cylinder, arranged as shown; the admission of steam to this cylinder is controlled by the driver. In our engraving the arm carrying the cam is shown standing at an angle of about 45° with the beam.

The framing is of the bar type almost universally adopted in the United States, and its form will be readily traced out from our illustrations. As will be seen from the right hand half of the engraving of the engine, the two cylinders are cast in one with the steam and exhaust pipe branches, the center for the truck being also cast on. This arrangement makes a very simple job of this part of the engine; but it is evidently one which is only trustworthy with the exceptionally high quality of cast iron which American engineers can—fortunately for themselves—secure. As is usual in American practice, the cylinders have loose covers at both ends, and the valve chests—which are situated at the top—are not cast in one with the cylinders, but are bolted on. The valves are of the Allen or Trick pattern, and they are driven through the intervention of rocking shafts, by link motion of the Stephenson type, having the expansion links hung from one side only. The chief dimensions of the cylinders and valves, etc., are as follows:

	ft.	in.
Diameter of cylinders	1	6
Stroke	2	0
Length of ports	1	4
Width of steam ports	0	1 5/8
" exhaust ports	0	3
Outside lap of valves	0	0 7/8
Inside "	0	0 1/8
Lead, 1/8 in. at each inlet edge, equivalent to	0	0 1/8
Travel of valves in full gear	0	5 1/2
" eccentrics	0	5 1/4

The connecting rods have strap ends as shown, and there are four guide bars to each cylinder, the crossheads, which are wrought-iron forgings, being fitted with brass wearing surfaces.

The boiler is made entirely of steel, and is provided with an enormous grate area for burning anthracite coal. As will be seen from the engraving of the engine, the firebox extends laterally over the frames, and is provided with a grate of water tubes, there being, however, four solid removable bars placed as shown. The firebox crown is stayed directly to the crown of the firebox casing. The ash-pan forms two deep hoppers, one in front of and one in the rear of the trailing axle, as shown. The boiler tubes are of wrought iron. The boiler carries a capacious dome, on the cast-iron cover of which the safety valves and whistle are mounted. The regulator, which is of the equilibrium valve type, is placed in the dome. The chief dimensions of the boiler are as follows:

	ft.	in.
Diameter of barrel at smokebox end	4	2
Thickness of shell plates	0	0 7/16
Length of firebox inside	8	0 1/2
Width "	7	0
Total depth of firebox at front	4	3
" " back	3	8
Thickness of firebox tube plate	0	0 1/2
" " plates	0	0 3/8
Diameter of water tubes forming grate	0	1 3/8
Thickness " " "	0	0 1/4
Pitch " " "	0	2 7/8
Number of boiler tubes	198	
Outside diameter of tubes	0	2
Length of tubes	12	2 3/4
" smokebox	4	2
Diameter of chimney	1	6
Height of top of chimney above rails	14	2
" center of boiler	7	4
Distance between exhaust nozzle and base of chimney	0	10
Diameter of exhaust nozzle (single)	0	4 1/8
Total heating surface	1,400	sq. ft.
Grate surface	56	"
Flue area through tubes	3·5	"
Sectional area of chimney	1·77	"
Ratio of grate area to heating surface	1 : 25	
" flue area through tube to grate area	1 : 16	
Ratio of sectional area of chimney	1 : 31 7	

It will be seen from the above figures that the enormous grate area causes the ratios of flue and chimney area to that of the grate to appear abnormally small, although these areas are themselves amply large for the size of boiler. Of course, with such a large grate, the rate of combustion per square foot is very moderate. The smokebox is of much larger capacity than is usual, it being extended forward and intersected a little above its center by a horizontal sheet of wire netting—3½ meshes to the inch—through which the blast nozzle projects as shown. In front of the tubes also a sheet iron deflector is placed obliquely, the lower part being hinged so that the opening under the lower edge can be regulated at pleasure. The boiler is fed by two injectors, no pumps being used. The boiler is fixed to the frame at the smokebox end, while the firebox is carried by four vertical links hinged to it and to the frame, as shown in engraving, one pair of these links being at the rear and the other at the front of the firebox.

As will be seen from our engravings, the engine has no footplate in the rear of the firebox, the stoking being done from the tender. There is, however, a footplate running along each side of the firebox casing at a level considerably above the tender footplate. The footplates, or "running boards" along the sides of the engine, are also at this high level. The cab is of wood, and fitted with movable windows at the sides as well as in front, as is usual in American practice. The engravings show the engine as constructed for use on the Philadelphia and Reading Line; but its dimensions as first made exceeded those allowed by the loading gauges in use here, and in order to run on English lines the engine had to be modified in this respect. For the same reason the use of the high level footplates would on English railways involve considerable danger to the men. Altogether, regarding the engine as first built, it is somewhat difficult to see how it could be altered to suit English requirements without the accommodation for the driver being considerably cramped, while great inconvenience is likely to arise from the driver not being able to pass quickly from one side of the engine to the other. As to what has been done in the way of alterations to suit the engine for trial on the Lancashire and Yorkshire Railway, we are as yet without full information, but we learn that the width has been reduced by about 18 in. The tender, which carries 3,600 U. S. gallons, or 3,040 English gallons of water, is mounted on two four-wheeled trucks; the weight loaded is about 70,000 lb.

A number of runs were made with the engine we have been describing before it was taken off the Philadelphia and Reading Line, but we need here only mention two, made on May 14, 1880. On this day the first run was made from Philadelphia to Jersey City, a distance of 89·4 miles, in 98 minutes, giving a mean speed of 54·73 miles per hour. The load consisted of four cars, the total weight of engine, tender, and train being about 148 tons. On the return trip another car was added, bringing up the weight of the train to 168 tons, and the journey back to Philadelphia was performed in 100 minutes, giving a mean speed of 53·4 miles per hour. Each trip was performed without any intermediate stop, and all bearings ran perfectly cool. The highest speed attained during the trials was 81 miles per hour, a distance of 2·8 miles being run in two minutes, part of the way up an ascending gradient of 16 ft. per mile. The water used in first trip was 2,640 gallons, and during the return trip about 3,100 gallons. We hope shortly to have something to say of the performance of the engine in this country.—*Engineering.*

ON THE TRIPLE EXPANSIVE ENGINES OF THE S. S. ABERDEEN.*

By A. C. KIRK, Member of Council.

ECONOMY of coal in our steamships is a point of so great importance that any step in this direction is worth chronicling. Steamships are now making long voyages, and at high rates of speed, which, till within a few years ago, were made by sailing ships. To accomplish these profitably, economy of coal is all important. Every ton of coal saved means a ton of freight earned, and in many trades every stoppage to coal is a loss of time, besides the exorbitant rates for coal charged at these ports. Coal-saving, too, is equally important for high-speed steamers, as, unless their voyage is only one of the shortest duration, coal becomes the greatest weight the ship is burdened with. The obvious direction in which to look for saving is increase of pressure. Unfortunately, as we get higher in pressure, we do not by any means gain in efficiency in anything like a proportionate degree, and the time must come, may indeed not be far away, when further increase of pressure will not pay. This time has not come yet. When James Watt utilized the lower pressures, from 15 lb. downward, he unquestionably had at his disposal the most prolific portion. Pressure gradually rose—I am speaking now more particularly of the marine engine—to 30 lb., and sometimes 40 lb., but, used as the steam was, in one cylinder, exhausting direct to the condenser, little additional economy was gained by this increase of pressure. The variation in temperature, over 300° in the cylinder, was too great; steam was condensed at the commencement of the stroke when it had its full work before it, and re-evaporated toward the end, when it had little left to do but go straight to the condenser. Steam jackets ameliorated this action, but besides the difficulty of getting them attended to at sea, they effected their purpose imperfectly, and at a very considerable sacrifice of steam. The next step was to divide the work between two cylinders, effecting part of the expansion of the steam, first in one cylinder, and completing it in a second, thus limiting the range of expansion and of temperature in each cylinder. Several incidental advantages accompanied this change, which we need not advert to here. A marked economy followed this improvement, and when a pressure of 60 lb. per square inch was reached, the economy over the older form was very marked; in round numbers only about half the coal was required. For six or seven years the pressure in use remained, for the most part at 60 lb., but of later years a gradual and steady increase of the working pressure of steam in our steamships has taken place, 100 lb. being now not uncommon. So far, however, as the imperfect data obtainable of steamship performances at sea show, the increase in economy of fuel has made but little progress, and I am not aware that any perceptible increase of economy has been attained by exceeding 70 lb. to 75 lb. pressure. In fact, the compound or double expansion engine has relapsed into the condition of the old single expansion one. This gradual increase of pressure, using all the time the ordinary type of internally fired, fire-tube boiler, has dissipated at once the mistrust of boilers of larger diameters, and the craving for boilers composed of water-tubes, and other such complicated arrangements. These may yet have their day. However, I am indebted to one of these water-tube boilers for having driven me seriously to take up the question of utilizing advantageously steam of much higher pressure than was at that time generally in use.

While I was with Messrs. John Elder & Co., in 1874, Mr. W. H. Dixon, of Liverpool, anxious to attain greater economy of fuel, made up his mind to fit his steamer Propontis with high pressure water-tube boilers on Messrs. Rowan & Horton's patent, and thus I had to consider the best engine to utilize this high pressure steam advantageously. Being thoroughly convinced that the great secret of success in the ordinary compound engine of the day over the earlier simple engine (even the Woolf engine) lay in the range of temperature through which the steam in any one cylinder passed in the course of one stroke, being very much reduced (nearly halved in fact, compared with a single cylinder), it seemed to me that with these high pressures, we must use three successive expansions, and divide the total range of temperature into three parts. Of course this was incidentally favorable to a more uniform distribution of strain, reduced leakage to the condenser, etc. Thus the engines of the Propontis, constructed in 1874 for a steam pressure of 150 lb. per square inch, consisted of three cylinders of progressive capacities, the smallest being the high pressure to which the steam was first admitted; next the intermediate one to which the steam passed from the high pressure cylinder; and the third the low pressure cylinder, receiving the steam from the intermediate cylinder and discharging it into the condenser. The arrangement consisted of a three-throw crank, with a cylinder above each, and possessed no specialties of construction or design. Unfortunately the boiler very early gave trouble, and ultimately was taken out, the causes of which do not come within the scope of this paper, but during the time it worked at its full pressure I found, on comparing the diagrams with those of an ordinary compound engine, that these engines ought to have required only about 1½ lb. of coal per indicated horse power. The practical results of working the engines were satisfactory, no difficulties being introduced by the use of high pressure steam; indeed, they are at work to the present day, though at reduced pressure. For when Mr. Dixon took out the water-tube boilers, the idea still haunted most people that an internally fired boiler was unfit for such high pressures, and the new boilers of the ordinary type only carried 90 lb.—still a high pressure for such a boiler in the year 1876. These engines are still doing good work in the Propontis. From that time till January last year (1881), when Messrs. George Thompson & Co. intrusted to my firm (Messrs. R. Napier & Sons) the building of the steamship Aberdeen, I failed to find any one who cared to make so long a step, and in doing so I hope Messrs. Thompson will have their reward.

In designing a ship for the long voyage their ships make from this country to Australia and China, more importance attaches to a small consumption of coal than in ships making shorter voyages, and it was necessary to use every device to attain this end. The engines of the Aberdeen are essentially of the same design as those of the Propontis, the cylinders being 30 inches, 45 inches, and 70 inches by 4 feet 6 inches stroke. The boilers, two in number, are ordinary double-ended boilers, constructed entirely of steel, with six of Fox's corrugated furnaces in each, the total heating surface being 7,128 square feet. There is no superheater. The construction of these boilers for so high a pressure—125 lb. per square inch—was facilitated by their being built of steel and to Lloyd's, whose rules allow the shells to be made thinner than required by the Board of Trade, although the internal parts are as strong as those required by the latter. After all, the shell is the simplest and strongest part of a round boiler, where, even if built to Lloyd's, there is superabundance of strength, but to doubly insure success—the internal parts of a boiler being those which oftenest give trouble—they were made stronger than required by either Lloyd's or the Board of Trade, whose scantlings for these parts are practically the same. The high pressure cylinder was not jacketed, the second was jacketed with steam of 50 lb. pressure, and the low pressure one with steam of 15 lb. above the atmosphere.

The Aberdeen is a ship built of iron, both ship and engines being to the highest class at Lloyd's, 350 feet by 44 feet by 33 feet. When the ship was complete, 2,000 tons of dead weight were put on board, and arrangements were made to test the consumption on a six hours' run at 1,800 horse power; this, however, by the owners' desire, was reduced to four only. The coal was Penrikyber Welsh coal, and Messrs. Parker & Dunlop, who happened to be on board, kindly undertook to examine the state of the fires, and see the coal weighed. The result was a consumption of 1·28 lb. per indicated horse power. According to usual analogy, we should expect from this a sea consumption of good Welsh coal of from 1·5 to 1·6 lb. per indicated horse power. The next trial was to find the maximum speed, which, on four runs on the measured mile (occupying two hours), was 13·74 knots, the mean power being 2,631, and the consumption of coal during these two hours being 1 ton 17 cwt. per hour. I am aware that the consumption of coal on so short a trial is not of implicit value, but the trial was made with the utmost care, and is thoroughly reliable so far as it goes. The engine, I ought to mention, is fitted with Weir's feed heater, with a view to the better preservation of the boilers. I mentioned above that the high pressure cylinder was not steam-jacketed, while the others were. As it did not seem to me that the value of jackets could be great in such an engine, with so limited a range of temperature in any one cylinder, and a considerable speed of piston, I sacrificed the steam jacket in the case of the high pressure cylinder, purely from prudential motives (the voyage being a very long one), to avoid any chance of cutting, when worked with very little lubrication, as it was desirable the engine should. Further, when we take into account the thickness of the interior chamber of the cylinder and the speed of piston, it is not conceivable that the interior surface of the chamber can be maintained by the steam on the outside of it, at a uniform temperature. In fact, the slower an engine runs the more efficient the jacket becomes. There is no doubt that, in such an engine as the above, or, indeed in any compound engine when the range of expansion and temperature is kept within moderate limits, economy from the use of steam jackets is at least small; that, in fact, the steam condensed in the jackets, if admitted to the high pressure cylinder, would have been for all practical purposes as efficient. This has been a fortunate thing for the compound marine engine, as it is always extremely doubtful if, at sea, the steam jackets receive the attention they require to make them efficient.

These remarks do not apply when engines are being worked at comparatively low powers. I may mention that the weight of steam condensed in the jackets, carefully measured into a tank, was 3¾ per cent of the greatest weight of steam admitted to the high pressure cylinder (by diagram), the pressure on the jacket of the middle cylinder being 30 lb., and on the low pressure cylinder 10 lb. In a second experiment, the condensed water was still the same percentage when the pressure in each jacket was doubled. I may mention that the loss of steam from the high pressure cylinder to the low pressure, just before release, plus the steam condensed in the jackets, was the same as took place inside the cylinders with the steam shut off from the jackets. I do not, however, quote this as absolutely conclusive, for, by an omission, Weir's feed heater was connected and at work on both trials, abstracting a certain amount of steam from the low pressure receiver. Still, I feel certain the result is tolerably correct, as the quantity abstracted by the heater must have been very nearly in the same proportion on both occasions. But a much more conclusive argument is to be found in the trials of a compound engine at Blackburn, made by Mr. Longridge (see *Engineering*, February 24, 1882), where it will be found that the feed water per indicated horse power per hour was, when no steam was in the jackets, 16·87 lb., and when all the jackets were supplied with steam, 17 lb.; on a second trial, the figures were respectively, 16·97 lb. and 17·16 lb. Unfortunately, at sea, it is extremely difficult to get data of this sort with the completeness Mr. Longridge was able to carry out on land. I made complete arrangements for some further experiments on the way from Glasgow to London, but owing to the state of the weather, my good intentions, to a great extent, fell through.

The form of engine adopted on board the Aberdeen of three cylinders, each over a crank, though a very convenient form for overhauling and giving a very uniform rotary motion, is not, by any means, the only form in which such an engine can be arranged. Indeed, from the unwieldy dimensions the low pressure cylinder would attain, it would not be advisable for large powers. About four years ago—

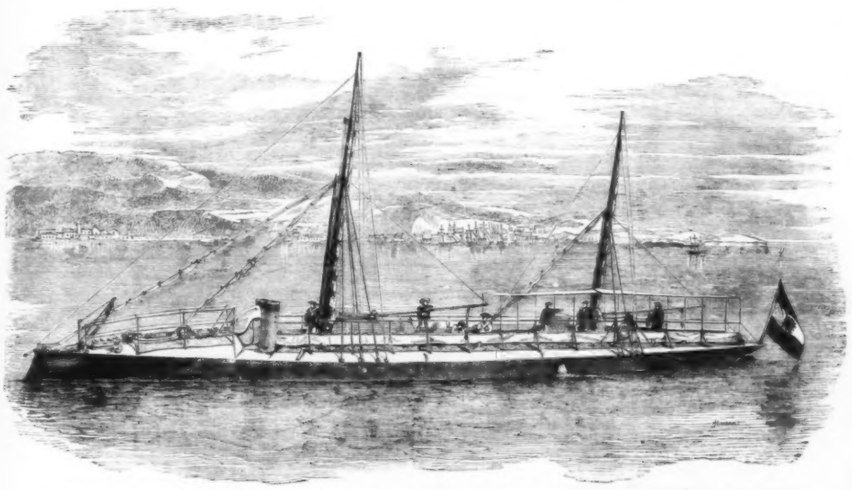
* Read at the twenty-third session of the Institution of Naval Architects.

but several years subsequent to the Propontis – Messrs. Douglas & Grant, of Kirkaldy, made a comparatively small set of marine engines for the Isa, with triple expansion, by placing the first, or high pressure, above what in an ordinary two cylinder compound engine would be the high pressure cylinder. This makes a neat, and in some cases, a convenient arrangement, but is open to the objection that, if you make the ratios of expansion approximately equal in each cylinder, the strains are very unequal, as also the several ranges of temperature. A better arrangement is, to have two low pressure cylinders, with the high pressure cylinder on top of one, and the intermediate cylinder on the top of the other. This arrangement is adapted to high powers, and does not occupy any excessive length. It is also the best plan for altering a compound engine of the present type into a triple expansive engine, as it does not alter the strains on the cranks, connecting rods, etc. It further lends itself to certain horizontal arrangements of engines, as are used in unarmored ships of war. The weight of the machine would not be perceptibly increased, while the weight of coal to be carried would be considerably reduced.

NEW TORPEDO BOAT.

WE give an illustration of a torpedo boat recently constructed by Messrs. Yarrow & Co., for the Argentine Government, which differs from similar boats hitherto built, inasmuch as it is fully rigged for sailing very long distances which would be too far to steam except by stopping at intermediate ports for fresh supplies of coal.

Messrs. Yarrow & Co. built two of these vessels for the Argentine Government last year, and they were navigated under canvas from London to Buenos Ayres, a distance of over 6,000 miles, arriving in perfect safety and in good condition, turning out to the entire satisfaction of the Argentine authorities. This firm has just completed two more for the same Government, which are now on the point of leaving England for South America. They are of the Batoum type, 100 ft. in length by 12 ft. 6 in. beam, and adapted for ejecting two Whitehead torpedoes from the bow by means of compressed air. They are capable of steaming when fully equipped at a speed of 19 to 20 knots, and can run for 1,000 miles at a 10 knot speed without requiring a fresh supply of fuel, the consumption at that speed having been found by actual experiment to be a trifle under 2 cwt. an hour.



NEW TORPEDO BOAT FOR THE ARGENTINE GOVERNMENT.

These boats are built of greater strength than is customary with torpedo boats generally, as they are intended to navigate a very exposed coast, where places of shelter are far apart. It was a very bold act on the part of the Argentine Government to be the first to send a vessel of this type across the Atlantic, and it has shown beyond all question that these boats are thoroughly trustworthy under sail as well as under steam, and proves them to be perfectly seaworthy.—*The Engineer.*

THE HUDSON RIVER TUNNEL.

By S. H. FINCH.

IT is assumed that you are sufficiently well acquainted with the general features and scope of the enterprise, and only a statement of its magnitude is here offered, viz.:

Two tunnels, both as to grade and alignment parallel, as near as may be; each to accommodate a single line of rails; east and west bound traffic.

Length of tunnels from shaft 83 feet, inboard on New Jersey shore to caisson 90, inside of bulkhead wall on New York side of the river 5,500.

Approaches at either end about 4,000 feet each. Greatest depth of water overhead at mean tide 60 feet.

Operations were begun in 1874, although but very little was accomplished, owing to litigation, until August, 1879, since which time the work has been carried on continuously.

The inauguration consisted in sinking an open shaft 30 feet internal diameter, with walls 4 feet in thickness, to a depth of 60 feet; at a depth of 40 feet an angular opening was made in the side of the shaft, and one end of an air-lock inserted, and the excavation begun.

Up to March 1, 1881, some 260 linear feet had been completed in the north and 250 in the south tunnel, when it became apparent that too much duty was put upon the compressors to maintain the required pressure, owing to numerous air-leaks, of greater or less dimensions, and it was decided to erect in each tunnel a bulkhead of somewhat permanent character, move the air-lock forward to this bulkhead, thus reducing the size of the air-chamber, and consequently the volume of air supply necessary to keep up the desired pressure.

But it was deemed best not to let off the pressure at the headings while this was done, which involved the construction of air locks in pieces that could be passed through the lock in the side of the shaft, the doors of which were 3 feet by 4 feet.

This, it is believed, happened to be the first instance where an air-lock was made in so many parts, and erected under pressure. The specification is inclosed, and it need only be stated here, what is obvious on inspection, that they have proved entirely satisfactory.

In the meantime the work was pushed forward until 450 feet in each tunnel had been completed, when the bulkheads mentioned were built 420 feet from the shaft, the air-locks set up in them, as shown on sketch, and in place of one large air chamber (in all about 900 feet long), it was possible to change to two, each only 30 feet in length.

Previou to this change there were three air chambers, of which I send you a sketch, which requires no further explanation, except it may be stated that the pressure west of the bulkheads was kept at 15 to 18 pounds, in the north heading 18 to 20, and in the south heading 22 to 24 pounds per square inch above atmospheric pressure. This, however, required too much care and attention, and a decision was finally reached to allow the pressure west of bulkhead to fall to normal condition, and on August 11 the men were brought out of the heading, and the air allowed to escape from as many openings as could be made through steam, air, and water pipes leading to or from this portion of the work. About an hour was required for the pressure to run down to 1 pound per square inch as indicated on the mercury column in engine room; no further decrease could be gained, owing to leakage from the other chambers, and the door of air-lock was forced open with a hydraulic jack, and Mr. D. C. Haskin, the originator of the tunnel, entered without the process of "locking" through.

Shortly after, however, the door of the old lock was closed. As the bulkhead in the north tunnel had been but recently built it was thought best not to subject it to a pressure of more than 20 pounds to the square inch, and orders were given to let the pressure in the headings run down to that. When the pressure was let off from the main part of the tunnel there was far more air leakage through and around the bulkhead walls than was anticipated, so that the pressure ran still lower, though the compressors were run at as high speed as was consistent with safety. The reduced pressure in the south heading was not sufficient, and the silt moved slowly in some 25 feet.

The bulkhead walls were of brick, four feet in thickness, backed by a solid timber wall of yellow pine, 12 inches by 12 inches, and strongly braced, as shown on sketch. Two locks were set up in each bulkhead, either of which would contain all the men engaged at any one time in the heading, and instructions given to keep one of them at all times open in that direction, in order to secure a retreat for workmen in case of accident resulting in an influx of material at the heading that could not be controlled. This probably increased the confidence of the men—if, indeed, it were necessary—although subsequent experience seems clearly to prove that no probability exists for this precaution, as the silt moves very slow when entirely relieved of pressure from within the air chamber. Two locks are recommended, however, in similar cases, entirely from an economical point of view, making it possible to pass materials, either of excavation or for construction, through them with so much greater expedition and convenience.

Previous to the construction of the bulkheads the excavation was carried on by mixing the silt with about 25 per cent. of water, and forcing it out with air pressure, as the usual practice; since then, however, until the 1st inst., the excavated silt has been removed by an "Eads sand pump." This gave good results, taking out sometimes as high as 30 per cent. of silt, but in consequence of the great distance there began to be indications that the limit was approached. At this time a "silt pump," designed by Mr. Chas. W. Clift, M.E., of the tunnel, was tried and found to be very satisfactory until the present time, and, being a simple, straightforward contrivance, was much liked.

The experiment is now being made of removing the silt from the heading in its natural condition, and as yet it is impossible to state as to the relative economy. The hydraulic method of excavation was rapid, but considerable inconvenience was experienced from the waste water; on the other hand, in sending the silt out dry it requires more handling, but leaves the heading in much better condition for putting masonry in.

Of the temporary entrance from the shaft to the tunnels there yet remained a short wedge-shaped section to be constructed, and which had been under consideration during the whole year, 1881, and of course various methods had been proposed, discussed, and criticised, and rejected. The writer, fortunately, was the author of the last plan suggested, which was adopted, and which consisted in simply closing the doors of the old air-lock, increasing the pressure within again, and drifting westerly from the chamber joining the tunnels to the shaft.

Thus two short sections of tunnel were built without noteworthy incident, unless perhaps mention may be made of the relief afforded by pumping from the stand-pipe in the shaft some 25 feet distant, which appeared to reduce the pressure, and at all events, the volume of water when the excavation was going on.

It may be better, by way of explanation, to state that it was necessary to remove nearly all the overlying silt at that point and expose the water-bearing strata of sand, and also that during the three weeks that the above work was going on, a horse was kept continuously under a pressure averaging 10 pounds per square inch above the atmosphere. A loss of horse power was calculated, but like many other well calculated plans, they went astray (for the horse still lives).

Now of the processes in vogue at the heading, the manner of advancing or driving the pilot forward may first be considered.

The pilot is 6 feet 6 inches in diameter, made up of 10 plates in each ring about 2 feet wide by 3 feet long, with angle bars 4 inches by 4 inches by ⅜ inch on the inside for bolting the plates and successive rings together.

The operations are—first, to make an open cut in the heading of sufficient size to admit one plate, which is supported by bracing from the bottom of the cut; another cut is then made at one side and a second plate put up and bolted to the first; then a third plate is put up on the other side of the first, and other plates are added on alternate sides, working downward until the ring is completed.

Then a second ring is put up in advance by a like procedure; it is also securely bolted to the first ring; work in driving the pilot forward is kept up until a distance of about 40 feet beyond the heading is reached, when the work is suspended to allow the finished tunnel to overtake the pilot, when work on both pilot and tunnel will be carried on simultaneously.

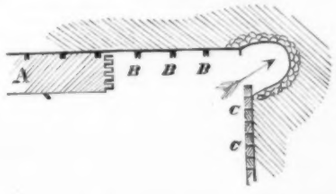
The back end of pilot usually extends 10 feet or more into the completed tunnel, from which it is firmly held by braces. The forward end being well advanced into firm silt, it is practically immovable, and, together with its advantage as an exploring agent, it forms a kind of bridge or brace against which radial braces are set to hold the iron shell in place while the masonry is being built.

After which uses the rear rings are taken down, carried forward, and bolted on at the front end to do duty over again.

The iron shell of tunnel is put up in much the same manner, except that these plates remain as a part of the structure.

There have been, however, several occasions when the following novel and somewhat difficult undertaking has been successfully performed, viz., that of making an opening of the required dimensions to insert a plate without excavating any material; this would occur when soft silt was encountered, or, as we call it, when from any cause the heading became "demoralized."

The following figure may assist somewhat in making the description clearer, where *a* represents the end of finished



brickwork, *b*, *b* rings of the iron shell, *c* a temporary bulkhead of 4 inch by 6 inch timber, or sometimes 2 inch plank doubled. But the work must go on, and a hole is cut in the bulkhead large enough to admit a man's hand. Instantly the silt begins to ooze in and the air to escape. But a man stands ready with balls of quite dry silt brought in for the purpose, from 4 to 6 inches in diameter, which were rapidly plastered into the soft ooze and pressed back; thus the progress of the silt was stayed. Carefully one ball after another was inserted of this puddle, and gently pushed backward until a kind of skin or shell was formed of it, these successive additions being pressed together until an air-tight concavity had been made.

Then a gentle onward motion was given and continued till the opening assumed dimensions sufficient to put up the plate, which advanced the heading 2 feet 6 inches by 4 feet of the circumference.

Occasionally the skin of puddle would become impaired and the soft silt force its way past the hand; then the air would escape in considerable volume with a sound peculiarly suggestive and threatening (should be heard to be appreciated), bringing all hands and the liveliest kind of work to repair the breach. Sometimes it could be repaired with one or two more balls of the hard silt; at others bags of sawdust and short pieces of plank and anything that came to hand had to be used. But the excavation would be made and the plate put in place without taking any material from the heading, although 4 hours' work of 12 to 15 men would now and then be required.

Again, the pressure of air required for carrying on the work by the pneumatic process is determined chiefly from day to day by actual observation, although the theoretical pressure due to a column of water of the height or depth of the work is a very close aproximation, and this is varied only as the silt becomes soft or dry and flaky. If the former, the pressure is increased from ¼ to ½ pound per square inch; if the latter, the pressure is reduced, the maximum variation not exceeding three pounds per square inch.—*Franklin Journal.*

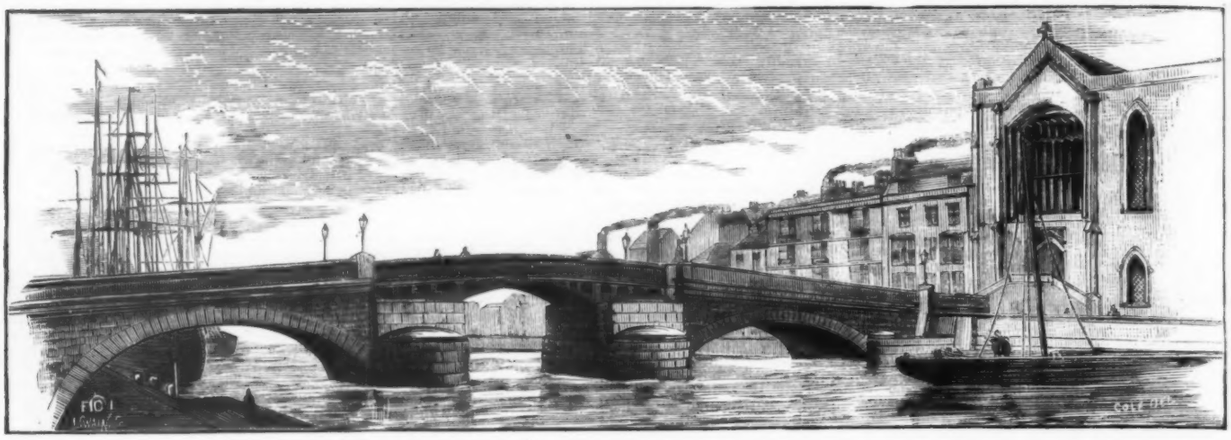
A NEW APPARATUS DESTINED TO SHOW THE DISSOCIATION OF AMMONIACAL SALTS.

By D. TOMMASI.

This apparatus, the *dissocioscope*, is composed of a glass tube 20 to 25 centimeters in length, by 3 or 4 centimeters in width. In the interior is suspended, by means of a platinum wire, a slip of blue litmus paper, previously steeped in a solution of ammonium chloride, which has been previously neutralized by the addition of a few drops of ammonia, avoiding excess. A cold saturated solution is required. The slip of litmus paper, after having been withdrawn from the liquid, is slightly pressed between two folds of blotting-paper, and is then suspended in the glass tube while still damp. To use the tube, it is simply plunged into boiling water, when the paper at once becomes red. On plunging it again into cold water, it is rendered blue again.

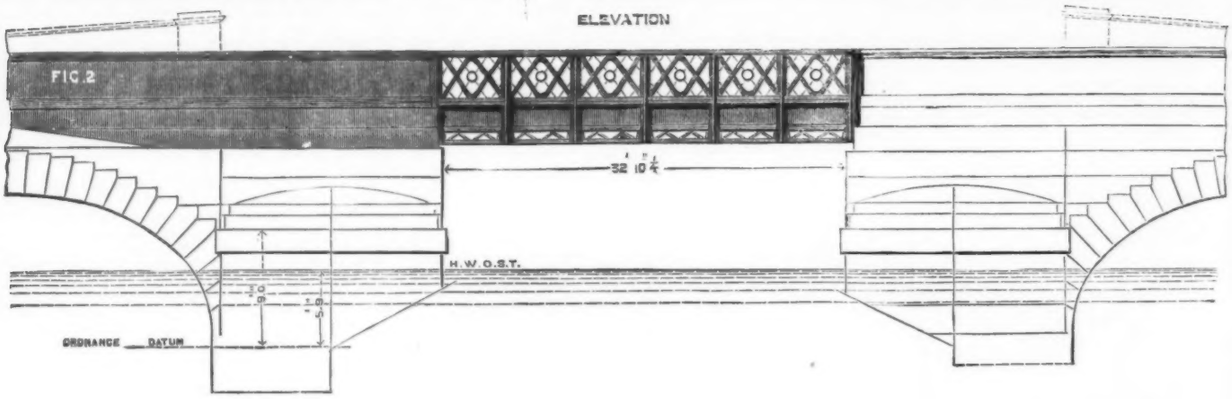
WEYMOUTH HARBOR BRIDGE.

MR. EWING MATHESON, M.I.C.E., LONDON, ENGINEER.



ELEVATION

FIG.2



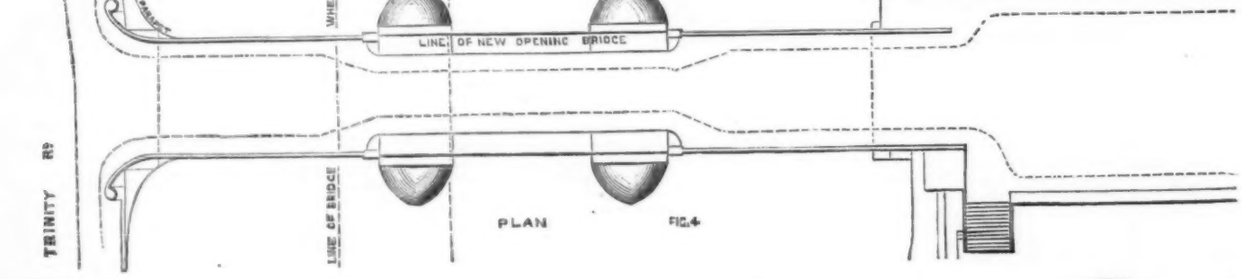
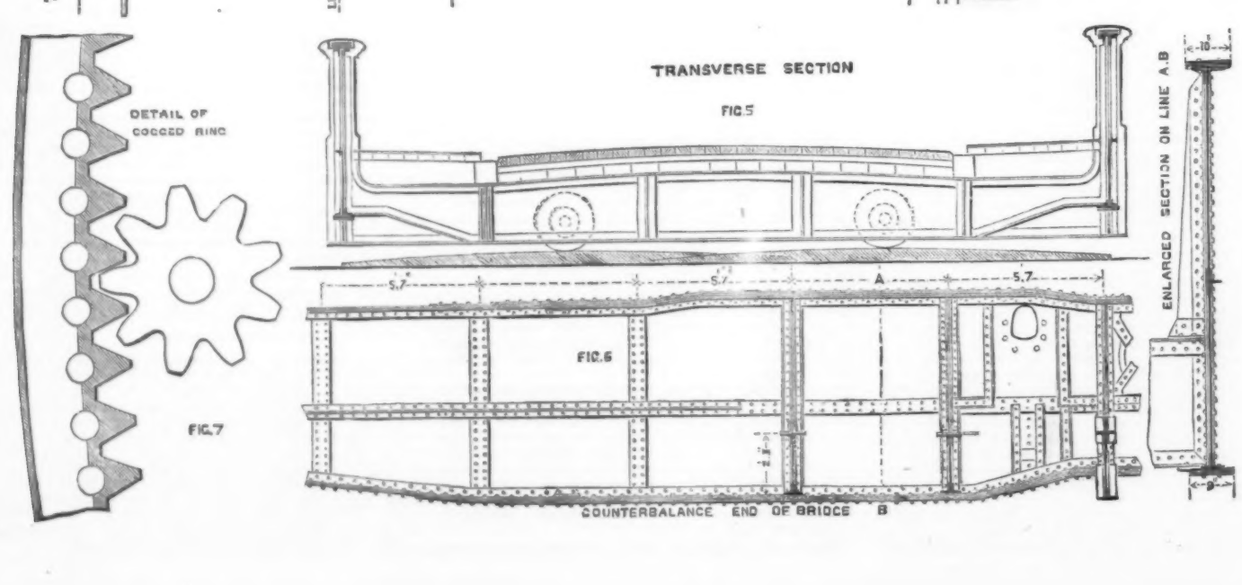


DIAGRAM VIEW OF OLD AND NEW SURFACES OF ROADWAY

FIG.3



PLAN FIG.4

FIG.7

WEYMOUTH BRIDGE.

THIS bridge, which crosses the harbor, joins Weymouth proper to the Melcombe Regis part of the borough, and with the exception of a decrepit wooden structure in the neighborhood, forms the only road connection between the island of Portland and the mainland. The bridge, as it stood in 1878, dates from about the year 1820, and was strongly built of Portland stone, as shown in Fig. 1. To allow of vessels passing in and out of the inner harbor or back-water, an opening was necessary, and the authorities of that day having at considerable cost built the side arches of masonry, wide enough for a double line of vehicles, fixed an iron opening bridge wide enough only for one line. Thus narrowed, the bridge proved quite inadequate for the traffic of recent years, and the steep gradients of 1 in 10 were not only difficult of ascent with heavy loads, but caused a continuous wearing away of the road surface by the wheel drags in the descent. Besides this the gearing worked with difficulty, and the two leaves of the opening bridge became so loose at their junction at the crown of the bridge as to render the opening and shutting difficult and unsafe. These inconveniences at last became unbearable, and the corporation asked Mr. Ewing Matheson, M. Inst. C. E., to advise as to the repair of the old bridge and as to the cost of a new one. Mr. Matheson reported that though the old iron structure might last a little longer before it became unworkable, it was so worn and corroded that it could not be taken to pieces and repaired with any hope of being put together again. On this report an alteration of the old bridge and the construction of a new opening span was decided on, and parliamentary powers were obtained in the session of 1879, the necessary funds being borrowed on the security of the tolls for vehicles—foot passengers going free—with the collateral security of the borough rates.

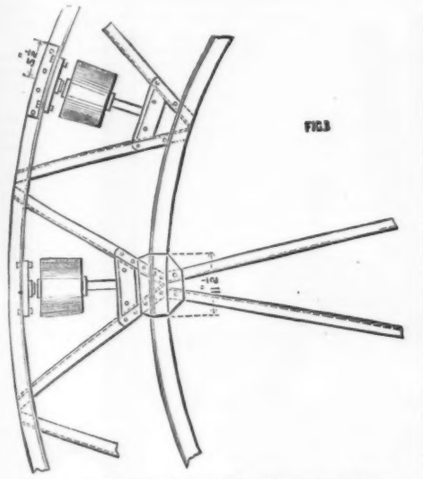


FIG.3

DETAILS OF LOOSE RING AND ROLLERS.

The scheme as carried out comprises the widening of the south approach, the lowering of the gradients, and the erection of a new opening span of the full width of the stone arches. The plan—Fig. 4—shows the widening of the south approach, the footpath and parapet at the curve being carried on iron girders spanning from the shore arch to the quay wall. The dotted lines indicate the narrow roadway, and the black lines the new opening bridge. As the opening span was much wider than the one it was to replace, a wider space on which to turn was necessary for it, but by removing the upper course of masonry on the south pier, a sufficient and solid base for the ironwork was provided, and in this was placed the roller-path and gearing, the opening span being in one piece and not in two leaves as before. The

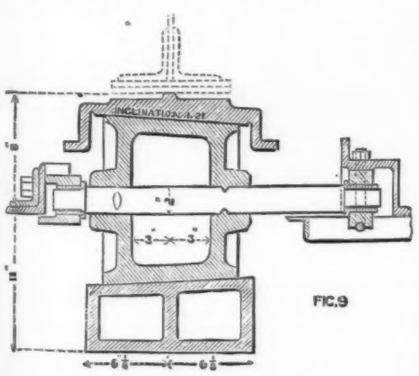


FIG.9

roadway of the bridge could now be made horizontal, enough masonry being removed from the haunches of the arches without touching the arch stones themselves. On the north approach, however, it was impossible to lower the road because of the headway necessary over the tramway by which the railway traffic has access to the steamer quay seaward. The turntable of the bridge rests on twenty-four cast iron rollers 12 in. diameter—Fig. 9—the upper and lower roller paths being also of cast iron. The rollers are held in a light wrought iron frame-work, being purposely left thus free. The main girders are as shown in the elevation, and are of plate iron, except where they form the parapet over the opening, they there being lattice. The roadway is carried on cross girders, on which, for the overhanging portion, are placed longitudinal planks, cross planks, and wooden blocks, while for the heel or balance weight portion are iron plates, concrete, and granite sets. The weight of iron in the movable part of the bridge is 79 tons, including the machinery, and the total weight, including concrete and paving, is 207 tons. The center of gravity of this weight coincides exactly with the center of the roller path, and as there are twenty-four rollers the weight on each is 8·6 tons The bridge when closed is calculated to carry a moving load of 100 lb. per superficial foot. The moving mechanism is double, *i. e.*, there is a pinion under each footpath working into the same fixed rack—Fig 11—and operated by crank handles and gear, single and double, compactly arranged in the two parapets—Fig. 10—so as not to obstruct the traffic

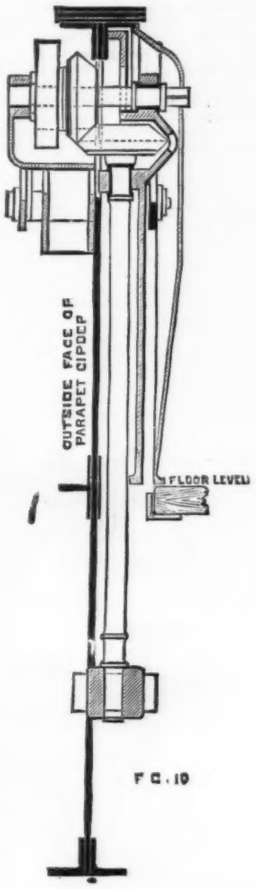


FIG.10

on the bridge, the workmen standing on the footpaths. The two sets of wheels can be worked separately or together, each being arranged on the planet principle to move in or out of gear.

It was first intended to utilize the water pressure in the town mains for turning the bridge, but as the opening takes place only about once a day, the expense of hydraulic apparatus was avoided, and the hand gear alone provided. The bridge was ready for traffic on May 14, last year, and the accommodation it provides, and the easier traction for vehicles, give great satisfaction. Mr. J. T. Whettam was the

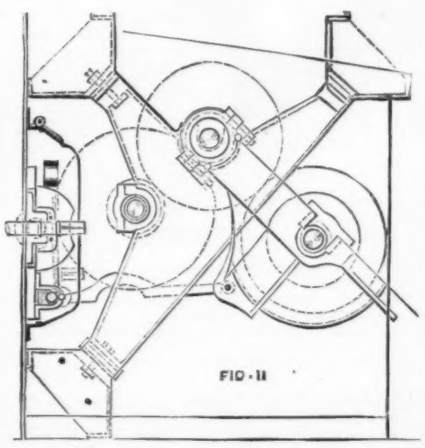


FIG.11

contractor, the ironwork being made by Messrs. Handyside, of Derby, and the opening gear by Messrs. Brinjes & Goodwin, of London. The total cost was £5,000.—*The Engineer.*

ELECTRIC TRANSFER OF ENERGY TO GREAT DISTANCES.—With Gramme machines of the small kind, weighing about 100 kilos, and modified according to the principles which the author has indicated, he has obtained a work of 37 kilogrammeters, the resistance interposed between the motor and the receiver being 786 ohms, representing the distance of 78·6 kilometers of ordinary telegraph wire. This transfer is effected without the appearance of sparks at the brushes, the machine remaining perfectly cold, and without the necessity of taking special precautions for the isolation of the conductors.—*M. Deprez.*

DESCRIPTION OF THE DAVIS ISLAND COFFERDAM OF 1881.*

By MR. WM. MARTIN, C.E.

THE navigable pass is that portion of the dam over which the greatest depth of water is always attained, and extends out into the river at right angles to the lock a distance of 558·89 ft. The cofferdam extends out from the river lock wall a distance of 612 ft., and parallel to the current of the river, a distance of 237 ft., including an area of 3½ acres. The area thus inclosed, besides giving the necessary space required for the dam, gave ample room for all the machinery of construction. A cofferdam may be described as a water-tight wall constructed around the site of any work for the purpose of laying dry the foundation of pier, wall, or any other structure that may be intended, by pumping out the water from the area thus inclosed. The methods used in different works vary according to the uses intended and the facility for procuring the materials of construction The preliminary step taken in the one which is the subject of this paper was to drive two rows of oak piles 15 in. in diameter and 20 ft. long to an average depth of 8 ft. at a distance of 15 ft. 8 in. transversely and 21 ft. longitudinally between centers, between which the frame-work was constructed, the piles serving to hold the frame-work in position until the puddling was placed. The frame-work consisted of three rows of stringers placed 12 ft. 4 in. apart, between which the sheeting was placed vertically and driven into the gravel 2 ft. The joints of the sheeting were covered with a 1 in. strip 6 in. wide to prevent leakage of the puddling. At the top of the sheeting are spiked two string pieces 2 in. by 13 in. on each side of the sheeting to form a bearing for the joist on which the deck was laid, also to bind the tops of sheeting together. The stringers were placed at the centers of pressure of rectangles of equal pressure, and were united together by a scarf joint with an iron rod passing through the entire width of the cofferdam with a nut on each end. One set of workmen assembled the stringers both in respect to height and width, and were followed by another set who drove the sheeting, and still by another who trimmed the tops of the sheeting and put on the 2 in. by 10 in. string pieces, the joists, and the deck. The most interesting part of the work was the placing of the puddling, and to which this paper chiefly refers. The total length of the cofferdam was 1,437 ft.; 379 ft of it was puddled by material taken from the cofferdam used in the construction of the river wall; the remaining 1,058 ft. was puddled by material obtained on Davis Island. The method employed in puddling the cofferdams of the land and river walls was to deliver the material in cars by a tramway from the point of excavation to the river, where it was loaded into boats, from thence transported across the river, where it was delivered into the framework of the cofferdam by hand labor, and having to be watered to settle it. The method employed in puddling the cofferdam of the navigable pass was by forcing the material, by means of a centrifugal pump through a pipe, from Davis Island to the cofferdam, the plant of which consists of boiler, engine, piston pump, centrifugal pump, delivery pipe, and the necessary steam and water connections. The pump, which was of the ordinary centrifugal type, was located on Davis Island, a distance of 900 ft. from the cofferdam. Alongside and beneath the pump was a tank for mixing the puddling material, 8 ft. in diameter and 4 ft. deep, sunk to a depth sufficient to secure fall for a water culvert from the river. The piston pump was connected to the delivery pipe by a Y-connection, and was used for clearing the delivery pipe, for priming the centrifugal pump, and keeping the sand from the packing (as described hereafter), and for furnishing water for the agitator hose and the steam boiler. The puddle material, which consisted of loam and sand, was obtained within a radius of 100 ft. from the pump by loosening up the soil with a plow and delivering it in close proximity to the tank by horse scrapers, and from thence delivered to the tank by shovels, where it was mixed with water from the culvert and kept agitated by water from hose pipes in the hands of the workmen to prevent the mixture from settling in the bottom of the tank. The puddle material so mixed was taken up by the feed pipe of the centrifugal pump and forced through the delivery pipe to the coffer, the distance to which was constantly increasing owing to the advancement of the completed work. The delivery pipe was laid from the centrifugal pump along the bottom of the river, and thence rose to about 1 ft. above the top of the cofferdam by an easy ascent, avoiding any sharp angles. On the pipe at the pump a pressure gauge was used for the purpose of detecting any stoppages in the pump or delivery pipe whereby the free working of the pump might be impaired. These were frequently caused by the puddle material being fed too thick. When the gauge indicated a stoppage the operator slackened the speed of the centrifugal and opened the valve in the wye connection to the piston pump. A stream of clear water was then thrown from the piston pump through the delivery pipe at high pressure, and the pipe was cleared. The check valve in the delivery pipe between the wye connection and the centrifugal pump prevented a back flow into the centrifugal pump. On the bottom end of the feed pipe was a screen with meshes of one square inch to prevent stones, roots, or any material which might prevent the free working of the pump from being taken up by the feed pipe. Above the screen and in the same casing was placed a foot valve for the purpose of holding the priming. One of the principal difficulties experienced in working the pump was the rapid wearing of all the parts of the centrifugal pump with which the sand came in contact. The casing, which was originally ⅜ in. thick, wore through in about ten days. This was renewed by a casing 1 in. thick, which performed all the work required. The stuffing box wore rapidly until the following device was applied: A screw was cut in the chamber in the opposite direction to the motion of the shaft. A pipe was put in back of the packing and connected with the piston pump. Water was forced through this around the shaft, and being under a greater pressure than the centrifugal pump, prevented the puddle material from getting into the stuffing-box. Water so applied performed a double duty, acting as a lubricator and preventing the shaft from heating. At the discharge end of the delivery pipe the puddle material was deposited in the frame-work of the cofferdam and flowed off for a distance of a few hundred feet, depositing in a hard and solid mass. Being delivered in a liquid form, it penetrated every crack and crevice in the framework and required no ramming or watering to settle it. A point noticed in the mass was, that the puddle material composed of loam and sand in its original state, as on Davis Island, was completely separated.

*Read before the Engineers' Society of Western Pennsylvania, December 20, 1881.

The loam being the lighter body was kept longer in suspension and settled on top of the sand. There was delivered into the cofferdam by the above described process 5,784 cubic yards of puddle material in twenty-three days' time, equal to 251·4 cubic yards per ten hours working time, or 25·14 cubic yards per hour. The cost of this was as follows:

Cost of pump	$145 00
Repairs, fittings, etc	382 25
Pipe	364 09
Fuel	38 35
Cost of labor, erecting machinery, making excavations for tank and water culvert feeding the centrifugal pump, etc	3,647 07
Total	$4,575 76

A comparison of the above figures with the cost of the puddling of the river wall cofferdam, which was procured from Davis Island as described, and the cross-section of which was the same, shows as follows:

	Length. ft.	Total Cost.	Cost per Lin. ft.
Cofferdam of river wall	1,165	$6,628 37	$5 69
Cofferdam of navigable pass	1,085	4,576 76	4 22

During the construction of the river wall cofferdam 12½ cents per hour were paid to laborers, and 22½ cents per hour to the mechanics, while during the construction of the navigable pass cofferdam laborers received from 17½ cents to 20 cents per hour, and mechanics from 25 cents to 27½ cents per hour. This makes the above statement still more favorable to the method of pumping. The dimensions of the principal parts of the machinery were as follows:

Tubular steam boiler	36 in. diameter, 16 ft. long.
Steam engine	10 in. diameter, cyl. 10 in. stroke.
Piston pump { steam cyl.	12 in. diam'r, cyl. 18 in. stroke.
Piston pump { water cyl.	6½ in. diam'r, cyl. 18 in. stroke.
Centrifugal pump	4 in. diameter of discharge.
Delivery pipe	4 in. diameter.
Clearing pipe	2½ in. diameter.
Priming pipe	1½ in. diameter.
Lubricator pipe	1 in. diameter.
Agitator hose	1½ in. diameter.
Steam pipe to engine	2½ in. diameter.
Steam pipe to piston pump	2 in. diameter.
Band wheel on engine shaft	4 ft. 6 in. diameter.
Pulley on centrifugal pump shaft	10 in. diameter.
Width of driving belt	10 in.

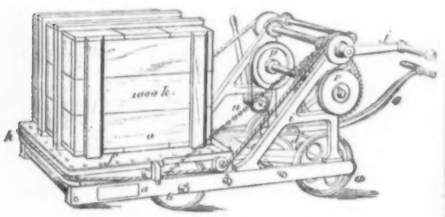
The pressures carried were as follows:

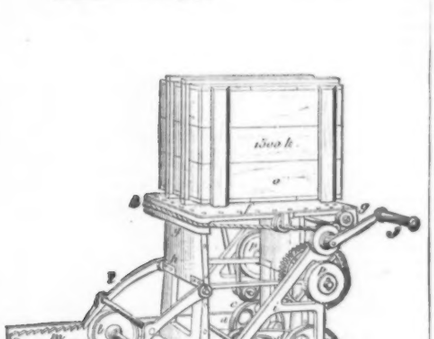
Steam boiler pressure	100 lb. per square inch.
Gauge on piston pump	70 lb. per square inch.
Gauge on delivery pipe	35 lb. per square inch.

The plant of the above described process, as originally designed, was very much simplified during the progress of the work, much that was complicated having been omitted for more simple devices. The cost of placing the puddling was thereby considerably increased. It is believed that with the improved machinery, as described above, the puddle material can be placed at one-half the figure given.

POIROT'S ELEVATOR TRUCK.

THE accompanying cuts represent an apparatus recently invented and put into market by Mr. Paul Poirot, of Paris, and called by him an elevator or hoist truck. It is designed chiefly for loading and unloading merchandise on carts or drays, although it may be likewise used for other hoisting





ELEVATOR TRUCK.

purposes where the height to be reached does not exceed four feet.

When the hoisting is to be performed in factories, at railway stations, on docks, or anywhere that cranes are employed, this apparatus will have no application; but, in all other cases, it will be found of undoubted utility when the weight to be raised is too great to be lifted by manual strength.

Every day we see carts being loaded and unloaded by means of an inclined plane—a method that is certainly convenient and practical, but, nevertheless, often laborious. Mr. Poirot's apparatus, therefore, comes to supply a want existing between the large elevating apparatus at present in use and inclined planes.

In addition to the facility that it offers for hoisting a load, it possesses the advantage of being portable.

The apparatus consists principally of a frame elevated but slightly from the ground, and carried on four wheels, two of which form part of a sort of fore-carriage. To this frame there are fixed by joints the four arms of a parallelogram, which are united in pairs, and carry a platform on which rests the load to be maneuvered. A special windlass fixed to the frame acts upon a cord, which raises or lowers the parallelogram, as may be desired. It will be readily seen that the platform may be lowered in such a way that there will be only a height of one inch or less to lift the goods to place on it. When the load is in place, it is only necessary to give the winch a few turns to elevate it to the desired height; and when the latter is reached, the frame of the parallelogram is almost vertical, as shown in one of the figures. The truck then having been wheeled up alongside of the cart to be loaded, there is nothing to do but to roll the merchandise off.

The inventor makes four sizes of the apparatus for lifting weights of 550, 1,100, 2,200 and 4,500 pounds respectively.

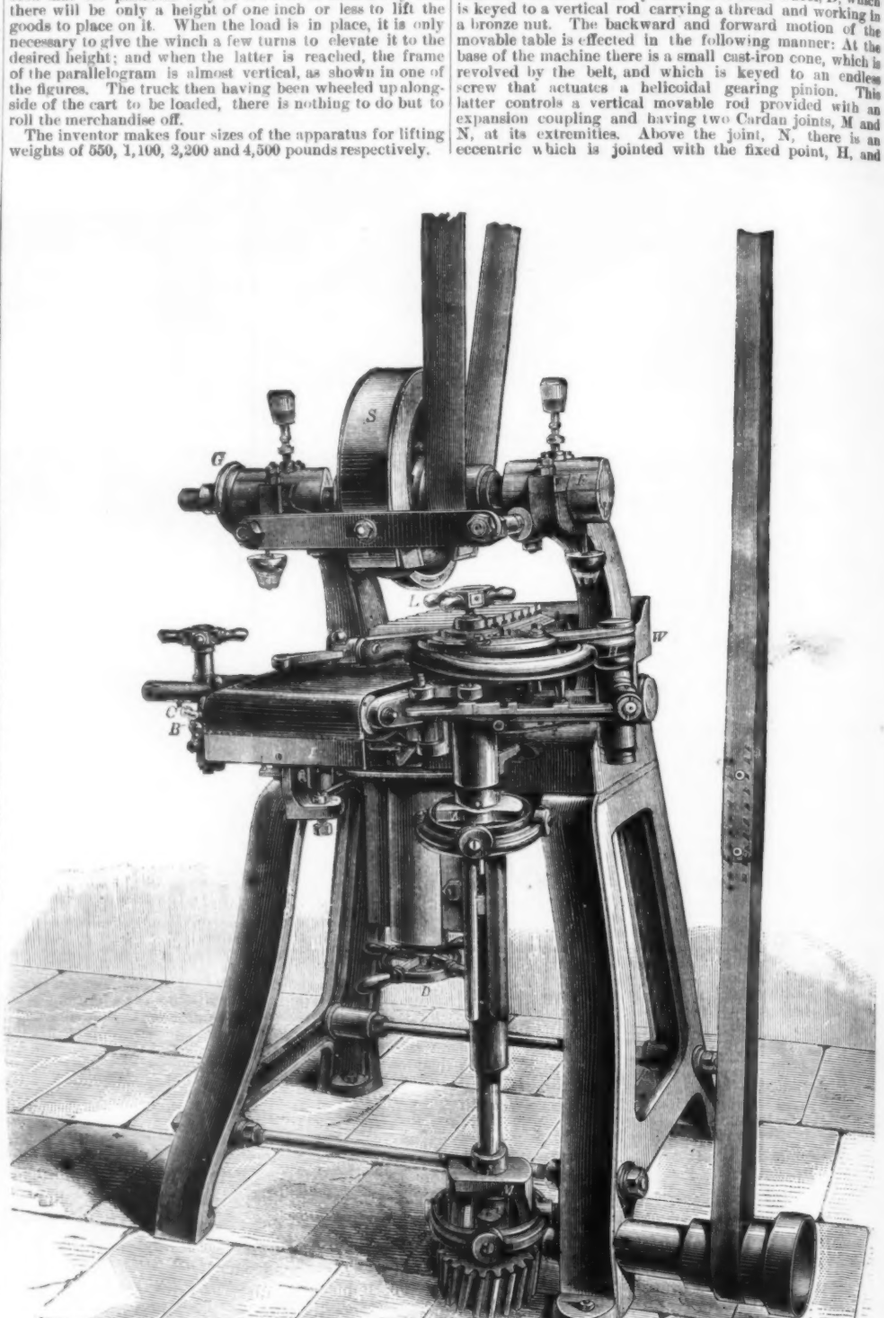
DESCRIPTION OF THE FIGURES.—*A*, frame of the truck; *b*, hind wheels; *c*, balance wheels; *d*, fore carriage and its wheels; *e*, lever for steering the fore carriage, for drawing the truck, and for directing the rear end of the truck by causing the latter to tilt; *f*, platform for reception of the load; *g*, parallelogram for guiding the platform during its ascent and descent; *h*, *f* and *a*, the four parts which go to form the parallelogram; *i*, the motive windlass, actuated by the winch *j*; *k*, the cord which transmits the action of the windlass to the hoisting system; *l*, safety ratchet, to prevent the platform dropping back in case the rope should break; *m*, safety rack into the teeth of which the ratchet falls during the ascent of the platform. In machines of from 550 to 1,100 pounds the ratchet is replaced by a safety chain, *n*, which should be slack, and not taut. This serves to hold the platform suspended in case the rope should give way during either the ascent or descent; *o*, the load to be raised, represented here by a box of merchandise. According to the purpose for which they are to be employed, these apparatus may be provided with a brake mounted on the windlass for facilitating the descent of the hoisting parts.

BOLLMAN'S AUTOMATIC EMERY GRINDER.

THE machine represented in the accompanying cut is designed for automatically rough finishing the surface of metals.

The emery wheel, provided with a guard, S, is actuated by power transmitted from the workshop, and which causes the revolution of the emery wheel axle resting on the bearings, F and G.

The table, L, designed to hold the piece to be worked, is raised or lowered at will by means of a hand-wheel, D, which is keyed to a vertical rod carrying a thread and working in a bronze nut. The backward and forward motion of the movable table is effected in the following manner: At the base of the machine there is a small cast-iron cone, which is revolved by the belt, and which is keyed to an endless screw that actuates a helicoidal gearing pinion. This latter controls a vertical movable rod provided with an expansion coupling and having two Cardan joints, M and N, at its extremities. Above the joint, N, there is an eccentric which is jointed with the fixed point, H, and



AUTOMATIC EMERY GRINDER.

is at the same time connected with a lever attached to the table, L, so that the backward and forward motion of the latter is produced by the rotary motion of the eccentric. The expansion coupling of the vertical rod which connects the two Cardan joints is designed to cause the length of the rod to vary according as it becomes necessary to raise or lower the movable table, L.

MACHINE FOR SHARPENING AND SETTING THE TEETH OF BAND-SAWS.

THE sharpening of band-saws by means of the file, and the use of the saw set for setting the teeth properly, requires a certain dexterity on the part of the workman, and always takes considerable time. For effecting these two operations by mechanical means, and consequently with great precision, Mr. J. Sudrat has devised a machine which we represent in the accompanying cut from drawings communicated to us by the manufacturer, Mr. E. Baras.

In this machine the saw is stretched over two loose pulleys trimmed with rubber, whose axles are mounted on a

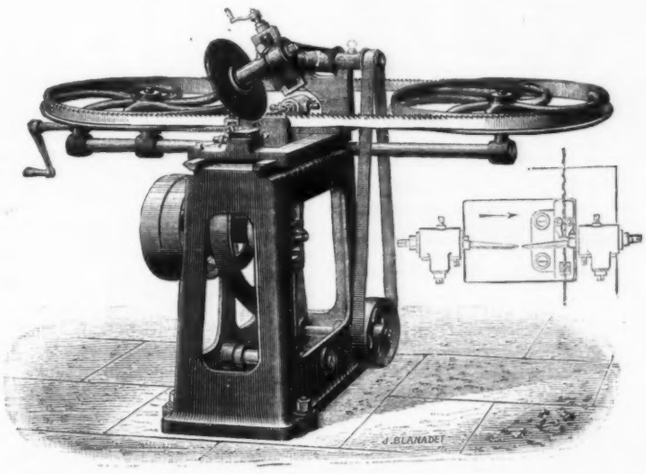
metallic tube fixed to the frame by a support. The axle of the pulley to the left is arranged so as to slide on this longitudinal tube by means of a nut-screw and winch, thus allowing the band-saw to be given the tension necessary in subsequent operations.

The saw is guided and held under an emery wheel by a lever jaw screwed to the frame, and, in addition, is kept in place by two springs acting on each side against the surfaces of the blade.

The upper part of the frame is arranged in the form of a lathe bench, and is provided with a slide hollowed out in its center, and which is given a backward and forward motion by means of mechanism within the frame. The driving shaft of the machine makes 40 revolutions per minute, and carries a loose and a fixed pulley and a plate connected with a winch which controls a crank coupled to the slide. The latter, at the extremity opposite to the saw guide, carries a puppet which is provided with a spring lever and a needle of triangular section inclined in the direction of the saw-blade. The inclination of the latter is regulated by means of a screw, and varies according to the distance apart of the teeth. To the principal slide there is also united a support provided with a socket which receives the cylindrical rod of a frame. This latter is made so as to slide with a small carrier of special form, which carries the axle of the emery wheel, making 1,600 revolutions per minute.

Before proceeding to the operation of sharpening, the emery wheel is first given the amount of inclination which corresponds with that of the teeth, and then it is profiled according to the depth between two successive teeth.

During the operation of the apparatus the wheel participates in the rectilinear motion of the carrier, and presents itself between two teeth to sharpen the upper part of one and the lower part of the other. As soon as the wheel has passed beyond its working position the needle enters one of the notches, and through its calculated inclination causes the saw to move from left to right to a distance equal to the pitch of the tooth. Thus, then, by means of this needle the sharpening is performed automatically.



MACHINE FOR SHARPENING AND SETTING BAND SAWS.

Afterwards the operation of setting is proceeded with. To effect this, the belt which drives the emery wheel is slipped off, and the wheel, no longer of use, is removed. Then there is mounted on the front of the principal carrier a second needle-carrier analogous to the first. This is the arrangement shown in the small sketch figured alongside of the perspective view of the machine. By inspecting this figure it will be seen that each of the needle-carriers is provided with a small projecting piece which strikes a tappet fixed near the saw at the end of each travel of the carrier. During this second operation the saw advances one tooth at each simple passage of the carrier; and, as the needle carriers, the projecting pieces and the tappets are placed symmetrically with respect to the saw, it results that the teeth of the latter are successively turned to the right and the left in a very regular manner.

Saws sharpened and set by this machine permit of rapid work being done with them, inasmuch as every tooth operates effectively. Mr. Sudrat's apparatus is therefore destined to render great services in all those wood-working industries in which band saws are employed. The type now being constructed by Mr. Baras, and which is the one shown in our cut, measures 0·85 of a meter in length, 0·80 of meter in width, 1·5 meters in height, and weighs 600 kilogrammes. *Revue Industrielle.*

PETROLEUM AS FUEL.

THE enormous quantities of petroleum which are now continually produced, and the occasional opening and development of new fields from which this substance is obtained (though generally accompanied by a greatly reduced production in the old fields) have led many to consider seriously what is to be done with this apparently magnificent combustible. And it is, perhaps, natural that this enormous production, with consequent low price per barrel of a substance which contains no ash worth mentioning, and which, by its composition, is all combustible, should lead to many attempts to utilize what is apparently so valuable a fuel as a means of heat production. Hence we have had from time to time prospectus after prospectus of companies which will revolutionize the heat production of the world, and give us light, heat, and power at almost no expense. Petroleum-burning furnaces for the manufacture of iron, and petroleum-burning locomotives, which were to be run at a fraction of the present cost for fuel, have claimed the attention of the world for a brief space and then passed into forgetfulness. This man's process and that man's process for utilizing petroleum as fuel have succeeded in drawing money from the pockets of capitalists; but as yet, we believe, none of the processes or attempts have succeeded in returning any money to the same pockets in the shape of dividends. The only impression these futile attempts have made seems to have been to convince the unfortunate stockholders and experimenters that there was something in the problem which they did not yet understand. And they must be regarded as fortunate if they became convinced before they had invested too much money on what we cannot but regard as an attempt to use crucible instead of Bessemer steel for rails, or gold instead of copper in an alloy for bearing metal.

But why cannot petroleum successfully be used as fuel in competition with coal, and what are the possibilities as to the use of petroleum for generating steam in locomotives? Why have so many attempts to utilize petroleum as a means of producing heat resulted in failure? The answer, in brief, is because at present prices the heat-producing power of a dollar's worth of coal is so much in excess of the heat-producing power of a dollar's worth of petroleum, that although coal is very wastefully burned in actual practice, and although the heat generated is very imperfectly utilized, especially in locomotives, yet no one has hitherto succeeded in burning petroleum in such a way as to compete with coal in cost of heat production. In other words, there is actually much more heat producing power in a dollar's worth of coal than in a dollar's worth of petroleum.

The following considerations will, we think, make this point clear. Coal may be regarded as a material consisting of combustible and non-combustible substances. The combustible substances in the case of bituminous coal are principally carbon and hydrogen, while the principal non-combustibles are ash and moisture. In the case of anthracite coal the principal combustion is carbon, and the principal non-combustible is the ash. In the case of petroleum, almost the whole substance is combustible, and consists of carbon and hydrogen. Now a pound of carbon when burned completely to carbonic acid will generate 14·544 heat units, a heat unit being regarded as the amount necessary to raise a pound of water one degree Fahr.

Again, a pound of hydrogen, when completely burned, will generate 62·030 heat units. With these data in hand, and knowing how much carbon and hydrogen a hundred pounds of coal or petroleum contains, it is easy to calculate the relative theoretical heat producing power of the two substances.

We assume that the percentage composition of bituminous coal is approximately as follows:

Carbon	85 per cent.
Hydrogen	5 " "
Ash, moisture, etc.	10 " "

Also that the percentage composition of anthracite is approximately:

Carbon	93 per cent.
Ash, etc.	7 " "

And that the percentage composition of petroleum is:

Carbon	86 per cent.
Hydrogen	14 " "

From these data it is easy to compute the relative theoretical heat-producing power of equal quantities of these three substances. This we find to be as follows, one pound of each substance being considered, viz.:

One pound bituminous coal will produce theoretically 15·465 heat units.

One pound anthracite coal will produce theoretically 13·526 heat units.

One pound of petroleum will produce theoretically 21·192 heat units.

We are aware that the figures given above are a little high, because the computation is based on the supposition that the carbon and hydrogen in the coal and petroleum are in the free state, whereas in the bituminous coal and petroleum they are chemically combined, and it will absorb a small amount of heat to take them apart. However, the error from this source will not seriously affect the comparison which we are trying to make.

If now anthracite coal be regarded as costing to large consumers $4.50 per ton, and bituminous coal $4.75 per ton, and crude petroleum 7 cents per gallon, which are very near to New York prices at present, it results that a dollar's worth of each of these three products will be as follows, petroleum being assumed to weigh 7¼ pounds to the gallon:

One dollar's worth of anthracite coal is 444 lb.

One dollar's worth of bituminous coal is 421 lb.

One dollar's worth of petroleum is 103 lb.

Then various weights of these three kinds of fuel, or a dollar's worth of each on the suppositions made above as to heat-producing power, will develop heat as follows:

444 lb. anthracite coal give 6,005·544 heat units.

421 lb. bituminous coal give 6,510·765 heat units.

103 lb. petroleum give 2,182·776 heat units.

Or, in other words, in accordance with the suppositions and data given above, the theoretical heat-producing power of a dollar's worth of anthracite or bituminous coal, at present prices, is nearly three times as great as the heat-producing power of the same value of petroleum. Here, then, is the reason why so many petroleum-burning schemes have resulted in failure, viz., petroleum does not have in it, in proportion to its cost, the heat producing power that coal has. It simply is not there; and as long as the present ratio of prices exists, engineers and experimenters who attempt to use petroleum as fuel must remember that they have a powerful rival in coal, and that there is in the very nature of the case a disadvantage in petroleum, which is well nigh staggering, and which may well cause them to hesitate on the very threshold of the problem.

We are perfectly well aware that the theoretical presumption of the subject just given is not the practical one, and that there are certain considerations in favor of petroleum from a practical point of view, which will somewhat modify the very wide difference between coal and petroleum given above. To these considerations we will devote a few words, as showing the possibilities ahead of petroleum for heat production.

First, it is probable that at least 15 per cent., and possibly 25 per cent., of the coal that is now put into the fire doors of locomotives escapes from the smokestack unburned in the form of cinders, black smoke, and unburned gases, and as unburned coal through the grate. If now petroleum can be burned in such a way that all of it is consumed, and very nearly its theoretical heat-producing power is developed, then certainly quite a percentage of the difference between coal and petroleum disappears.

Again, locomotives for burning coal are by necessity constructed with quite large flues, in order to avoid clogging by the cinders. This, of course, makes the heating surface less; and it is entirely possible that a petroleum-burning locomotive may be so constructed with smaller flues and more of them, with consequent greater heating surface, that a larger percentage of the heat generated will be utilized in the case of petroleum than in the case of coal. Still again, when rapidly burning a solid combustible on a grate, when a part of the combustible is gaseous or becomes so, and consequently needs air above the fire for its complete combustion, it becomes exceedingly difficult to so proportion the air drawn through and over the fire that just the right amount shall be used. Doubtless, therefore, in very many cases far too much air is used, and a reduction in the temperature of the hot gases takes place, with consequent loss of efficiency. If in the case of petroleum a proper proportion can be maintained between air and combustible, so as to give higher temperature to the products of combustion as they enter the flues, a gain in efficiency will be effected, which will help again to diminish the difference between coal and petroleum.

One consideration is certainly very strongly in favor of petroleum as fuel, and that is freedom from smoke and cinders. If, as seems to be allowed by all, petroleum can be burned so as to give no black smoke or cinders, then certainly railroad managers can afford to pay a little more than they are at present doing for the heat used in locomotives, especially in those used on passenger trains, or within cities.

The question whether coal will advance in price in the future, and petroleum diminish, we do not discuss any further than to say that well-informed oil men inform us that petroleum cannot be produced at the wells for less than 75 cents per barrel, and the difference between that price and the present one in the oil regions is not enough to hold out very strong encouragements for a diminution in the price of petroleum.

But imagine petroleum at present an economical fuel in competition with coal at present prices. We must then consider the effect of this new use of petroleum on the supply and the cost. The production of petroleum has been recently pushed to the uttermost, and amounts to 30,000,000 barrels (42 gallons each) per year. In heat-producing capacity, the above figures show that it requires 193 gallons of petroleum to equal one ton (2,000 lb.) of bituminous coal when combustion is perfect; so that the annual production is equal to about 6,500,000 tons of coal for making heat, with whatever addition may be due to the practically more perfect possible combustion of petroleum, which could hardly make the coal equivalent more than 8,000,000 tons. This is about one-ninth of the production of coal in the United States in the census year. But the petroleum production is now nearly all absorbed for illumination. If the equivalent of even 2,000,000 tons of coal a year should be required for making steam, the price would certainly rise greatly, for this is equal to one-fourth of our exports. And if the petroleum were required as fuel for other purposes than making steam, it would have to compete with the whole 71,000,000 tons of our coal production; that is, without an immense increase in petroleum production, it cannot possibly come into *general* use as a fuel, or even for making steam, without an immense increase in production.

In places where the space occupied by the fuel has an influence, petroleum has some advantages. A cubic foot of petroleum of 31° gravity weighs about 54 lb., while, according to Haswell, about 50 lb. of coal can be put into a cubic foot of space. Taking into account the heat-producing power of the two substances, however, we find that equal volumes of coal and petroleum will generate heat theoretically in the ratio of about 70 to 114, or, in other words, the same theoretical heat-producing power can be stored in about 40 per cent. less space in the shape of petroleum than in the shape of coal. This certainly is an advantage in favor of petroleum, which, at least for marine boilers, should not be overlooked.

Notwithstanding these several minor advantages, however, it is evident that at present prices the excess of cost of the heat-producing power of petroleum is so great that all efforts to substitute the liquid for the solid fuel must almost inevitably result in financial disaster.—*Railroad Gazette.*

FORMULA AND TABLES FOR THE HORSE-POWER OF LEATHER BELTS.*

By A. F. NAGLE, M.E.

$$HP = C\,V\,t\,w\left(\frac{S - 0{\cdot}012V^2}{550}\right)$$

$C = (1 - 10^{-0{\cdot}0077\alpha f})$

α = Degrees of belt contact.

f = Coefficient of friction.

w = Width in inches.

t = Thickness in inches.

V = Velocity in feet per second.

S = Stress upon belt per square inch.

Before proceeding to explain the above formula, I will call attention to the defect of all previous formulas.

* This formula was first announced at the first regular meeting of the American Society of Mechanical Engineers of 1881, Hartford, Conn.

In Mr. Samuel Webber's "Manual of Power," page 98, are given no less than five formulas for single leather belts, all of substantially the same form as the one given by Mr. Webber himself, viz.:

$$w = \frac{HP \times 5{,}500}{\text{velocity} \times \text{contact in feet.}}$$

This formula, expressed in terms of the diameter and revolutions and degrees of belt contact, becomes

$$w = \frac{HP \times 5{,}500 \times @}{360 \times Rev. \times d^2 \times \pi^2}$$

The notations are well understood, but attention is called to the fact that it makes the width of the belt vary inversely as the *square* of the diameter, inversely as the *simple* multiple of the arc, and that it takes no cognizance of the effect of centrifugal force; while all mathematical investigations and experiments show that the width should vary inversely as the diameter instead of its square, and the adhesion, or friction, varies as a logarithmic function of the arc of contact instead of a simple multiple, and that centrifugal force does diminish the effective power of the belt.

I find my data for this paper mostly in Mr. John H. Cooper's book "On the Use of Belting," wherein are published General Morin's experiments, and, later, those of Mr. Henry R. Towne.

The conditions for the transmission of power by a belt are dependent upon its

1. Strength and tension.
2. Coefficient of friction.
3. Degrees of contact.
4. Velocity.

1. STRENGTH AND TENSION.

Mr. Towne's experiments upon leather belts 3 in. wide, and $\frac{7}{16}$ in. thick, are generally accepted among engineers as furnishing reliable data for calculations of other sizes. Reducing to the unit of measure of one inch in width, he found the ultimate strength to be:

At the lacings, 210 lb., or per sq. in. of section,					958 lb.
At the rivets,	382	"	"	"	1,744 "
At the solid,	675	"	"	"	3,086 "

Mr. Towne adopts 200 pounds per inch width as the ultimate strength of laced belts $\frac{7}{16}$ in. thick, and takes $\frac{1}{3}$ of this, or 66⅔ pounds, as the working strength. This would be 304 pounds per square inch of section as a working tension. In my tables I have taken 275 pounds for laced belts, and 400 pounds for lapped and riveted belts.

This value is represented in the formula by S.

2. COEFFICIENT OF FRICTION.

The formula by which the coefficient of friction of a belt is obtained is expressed by General Morin as $f = 0{\cdot}783 \times \log. \frac{t}{t'}$ (1), when the angle of subtension is 180° and $\frac{t}{t'}$ the ratio of the greater to the lesser weight that will cause a belt to slip over a pulley. I will say that all mathematicians concur in the correctness of this formula.

From Mr. Cooper's book I take data which give the following value for f:

Experiments of the New York Belting and Packing Co. Cooper, page 195:

Leather on iron	0·292
Leather on leather	0·350
Leather on rubber	0·512
Rubber on iron	0·425
Rubber on leather	0·512
Rubber on rubber	0·606
xiii. Rubber on iron	0·279

Pages 121 and 241. General Morin's experiments, pulleys 4⅜ in. to 24 in. diameter, and pulleys in one case reduced to 60 per cent. of the width of the belt:

Leather in ordinary condition on wooden pulley	0·47
Leather in ordinary condition on iron pulley	0·28
Leather soft and moist	0·38

Pages 218 and 230. Mr. Towne's experiments with 3 in. and 6 in. belts, pulleys 12 in. to 41 in. diameter, and pressure varied 20 to 1.

Leather on iron (average of 168 experiments under the ordinary working conditions)	0·586
Least value	0·454
Greatest value	0·698
Adopted value	0·425
Nagle recommends and uses	0·400

3. DEGREES OF CONTACT.

The law according to which a belt transmits a force by virtue of its frictional resistance and arc of contact, is shown by Professor Rankine and other mathematicians to be expressed by the formula:

$$F = S\,(1 - 10^{-0{\cdot}00158 f @}) \qquad (2)$$

In which

F = Force transmitted.
S = Tension upon belt.
f = Coefficient of friction.
@ = Degrees of contact.

If we call the expression within the parenthesis, C, the formula would read

$$F = S \times C. \qquad (3)$$

Inasmuch as this formula is not easily solved, I have calculated the value of C for various values of f and @, and embodied the results in Table II.

4. VELOCITY

The velocity of a belt produces a centrifugal tension which is expressed by Professor Rankine as equivalent to "the weight of a piece of the belt whose length is twice the height from which a body must fall in order to acquire the velocity of the belt." Cooper, page 101.

By formula the centrifugal tension is

$$T = \frac{W V^2}{g} \qquad (4)$$

W = Weight of a unit of length of the belt.
V = Velocity in feet per second.
g = Velocity produced by gravity in one second.

W, the weight of a unit of the belt, is that of a square inch in area and one foot long. Leather weighing 56 pounds per cubic foot would give

$$W = \frac{56}{144} = 0{\cdot}388$$

$g = 32{\cdot}2$ feet,

making these substitutions in equation 4,

$$T = \frac{0{\cdot}388 V^2}{32{\cdot}2} = 0{\cdot}012 V^2 \qquad (5)$$

The centrifugal tension is a tension in addition to that existing when the belt is at rest or transmitting power at small velocities. Or, in other words, whatever we may determine to be the maximum stress to which the belt shall be subjected, its effective force for transmitting useful work must be diminished by the amount of the centrifugal force. That is, if S is the maximum stress to be put on the belt, and T the tension produced by the centrifugal force, the available force will be S—T, and equation 3 will really become

$$F = C\,(S - T),$$

or, substituting the value of T,

$$F = C\,(S - 0{\cdot}012 V^2) \qquad (6)$$

The horse-power transmitted is the product of the velocity in feet per second, V, multiplied by its effective force, F, and width, w, and thickness, t, divided by 550, or

$$HP = \frac{FVwt}{550} \qquad (7)$$

Substituting the value of F, as given in equation 6, we have

$$HP = CVtw\,(S - 0{\cdot}012 V^2) \div 550 \qquad (8)$$

This is a general formula, which holds good for leather belts, giving such value to S as the nature of the fastenings may determine. As before mentioned, for ordinary lacings I take S = 275 pounds, and for lapped and riveted joints, such as are applied to double belts and main drivers, S = 400 pounds. The two tables, III. and IV., are calculated for the two respective values of S. For these tables I have also taken the value of C from Table II. as 0·715, being the value for @ = 180° and f = 0·40. These are the ordinary conditions of belts in general practice. Should the degrees of contact be different than the 180°, a multiple will be found at the foot of the tables to make correction therefor.

For special cases of different values of the coefficient of friction and degrees of contact, reference must be made to Table II. for the value of C,

The tables are calculated for various thicknesses of belts. Belts of one maker run as follows: 1 in. wide, $\frac{1}{4}$ in. thick, 1¼ to 2½, $\frac{5}{16}$ in.; 2¾ and upward, $\frac{3}{8}$; $\frac{7}{16}$ in. is the ordinary single thickness, and $\frac{1}{2}$ in. double.

For the purpose of facilitating practical calculations, I have added Table I., so that the velocity of a belt, in feet per second, can be readily ascertained from its known diameter and revolutions per minute. Dimensions and revolutions not given in the table can be obtained by interpolation.

Example.—Required to find the width of a belt to transmit 150 H. P. on a pulley 54 inches diameter, making 260 revolutions per minute, and belt having 165° of contact.

In Table I. we find the velocity of belt to be about 61 feet per second. If a lapped and riveted belt and $\frac{3}{16}$ in. thick, it would transmit about 10·50 H. P. per inch, or it would be about 14·29 inches wide. As the arc of subtension is only 165°, about 5 per cent would have to be added to the above width.

FORMULA FOR THE HORSE-POWER OF LEATHER BELTS.

Table I.

VELOCITY OF A PULLEY IN FEET PER SECOND.

DIAMETER IN INCHES.	REVOLUTIONS PER MINUTE.										
	50	75	100	125	150	175	200	225	250	275	300
12	2.6	3.9	5.2	6.5	7.8	9.2	10	12	13	14	16
14	3.1	4.6	6.1	7.6	9.2	11	12	14	15	17	18
16	3.5	5.2	6.9	8.6	10	12	14	16	17	19	21
18	3.9	5.9	7.8	9.8	12	14	16	18	20	21	24
20	4.3	6.5	8.7	11	13	15	17	20	22	24	26
24	5.2	7.8	10	13	16	18	21	23	26	29	31
28	6.2	9.2	12	15	18	21	24	27	30	34	36
32	7.0	10	14	18	21	24	28	31	35	38	42
36	7.8	12	16	20	23	27	31	35	39	43	47
40	8.7	13	17	22	26	31	35	39	44	48	52
44	9.5	14	19	24	29	34	38	42	48	52	58
48	10	16	21	27	31	37	42	47	52	57	63
52	11	17	23	29	34	40	45	51	57	62	68
56	12	18	24	31	37	43	49	55	61	67	73
60	13	19	26	33	39	46	52	59	65	72	78
66	14	21	28	36	43	50	57	65	71	79	86
72	16	23	31	39	47	55	63	71	78	86	94
84	18	27	36	46	55	64	73	83	92	100	110
96	21	31	42	54	63	73	84	94	105	114	125

Table II.

VALUE OF $C = 1 - 10^{-0{\cdot}00158 f @}$.

f = Co-efficient of friction, @ = degrees of contact.

Value of f	ARC OF SUBTENSION = @.										
	90° .250	100° .277	110° .306	120° .333	130° .361	140° .388	150° .417	160° .444	170° .472	180° .500	200° .555
.15	.210	.230	.250	.270	.288	.307	.325	.342	.359	.376	.408
.20	.240	.270	.292	.314	.335	.356	.376	.395	.414	.432	.466
.30	.270	.295	.319	.342	.364	.386	.408	.428	.448	.467	.503
.23	.303	.331	.357	.383	.406	.430	.452	.474	.495	.514	.552
.25	.325	.354	.381	.407	.433	.457	.480	.503	.524	.544	.582
.28	.356	.387	.416	.444	.470	.496	.520	.542	.564	.585	.624
.30	.376	.408	.438	.467	.494	.520	.544	.567	.590	.610	.649
.33	.404	.438	.469	.499	.527	.554	.579	.602	.624	.645	.684
.35	.422	.457	.489	.520	.548	.575	.600	.624	.646	.667	.706
.38	.449	.485	.518	.549	.578	.605	.630	.654	.678	.697	.735
.40	.467	.502	.536	.567	.597	.624	.649	.673	.695	.715	.753
.43	.491	.528	.562	.595	.625	.650	.676	.699	.721	.741	.777
.45	.507	.544	.579	.610	.640	.667	.692	.715	.737	.757	.792
.48	.529	.567	.602	.634	.665	.690	.715	.738	.760	.779	.812
.50	.544	.582	.617	.649	.678	.705	.730	.752	.773	.793	.825
.53	.565	.603	.638	.670	.700	.729	.750	.773	.793	.811	.843
.55	.578	.617	.652	.684	.713	.739	.763	.785	.805	.822	.853
.58	.598	.637	.672	.703	.732	.758	.781	.802	.821	.838	.868
.60	.610	.649	.684	.715	.744	.769	.792	.812	.832	.848	.877
1.00	.798	.825	.849	.867	.887	.903	.917	.927	.937	.946	.960

FORMULA FOR THE HORSE-POWER OF LEATHER BELTS.

Table III.

HORSE-POWER OF A LACED LEATHER BELT ONE INCH WIDE.

Formula $HP = CVtw\,(T - .012 V^2) \div 550$.
For f = .40 and @ = 180°, C = .715; T = 275; w = 1"

VELOCITY IN FEET PER SECOND.	THICKNESS IN INCHES = t.						
	7/16 .143	3/16 .167	1/4 .187	5/16 .219	3/8 .250	7/16 .312	1/2 .333
10	.51	.60	.68	.78	.84	1.05	1.18
15	.75	.88	1.00	1.16	1.32	1.66	1.77
20	1.00	1.14	1.32	1.54	1.75	2.19	2.34
25	1.23	1.43	1.61	1.88	2.16	2.69	2.86
30	1.47	1.72	1.93	2.25	2.58	3.22	3.44
35	1.69	1.97	2.22	2.59	2.96	3.70	3.94
40	1.90	2.22	2.49	2.90	3.32	4.15	4.44
45	2.09	2.45	2.75	3.21	3.67	4.58	4.89
50	2.27	2.65	2.98	3.48	3.98	4.97	5.30
55	2.44	2.84	3.19	3.72	4.26	5.32	5.69
60	2.58	3.01	3.38	3.95	4.51	5.64	6.02
65	2.71	3.16	3.55	4.14	4.74	5.92	6.32
70	2.81	3.27	3.68	4.29	4.91	6.14	6.54
75	2.89	3.37	3.79	4.42	5.05	6.31	6.73
80	2.94	3.43	3.86	4.50	5.15	6.44	6.86
85	2.97	3.47	3.90	4.55	5.20	6.50	6.93
90	2.97	3.47	3.90	4.55	5.20	6.50	6.93

V becomes a maximum at 87.41 feet per second, = 5245 feet per minute.

Table IV.

HORSE-POWER OF A RIVETED LEATHER BELT ONE INCH WIDE.

Formula as in Table III., except that T = 400 instead of 275.

VELOCITY IN FEET PER SECOND.	THICKNESS IN INCHES = t.						
	7/16 .219	1/4 .250	5/16 .312	3/8 .333	7/16 .375	1/2 .437	1/2 .500
15	1.69	1.94	2.42	2.58	2.91	3.39	3.87
20	2.24	2.57	3.21	3.42	3.85	4.49	5.13
25	2.79	3.19	3.98	4.25	4.78	5.57	6.37
30	3.31	3.79	4.74	5.05	5.67	6.62	7.56
35	3.82	4.37	5.46	5.83	6.56	7.65	8.75
40	4.33	4.95	6.19	6.60	7.42	8.66	9.90
45	4.85	5.49	6.86	7.32	8.43	9.70	10.98
50	5.26	6.01	7.51	8.02	9.02	10.52	12.03
55	5.68	6.50	8.12	8.64	9.74	11.36	13.00
60	6.09	6.96	8.70	9.23	10.43	12.17	13.91
65	6.45	7.37	9.22	9.83	11.06	12.90	14.75
70	6.78	7.75	9.69	10.33	11.63	13.56	15.50
75	7.09	8.11	10.13	10.84	12.16	14.18	16.21
80	7.36	8.41	10.51	11.23	12.61	14.71	16.81
85	7.58	8.66	10.82	11.55	13.00	15.16	17.32
90	7.74	8.85	11.06	11.80	13.27	15.48	17.69
95	7.90	9.03	11.28	12.04	13.54	15.80	18.06
100	7.98	9.10	11.37	12.13	13.65	15.93	18.20
105	8.00	9.13	11.41	12.17	13.69	15.97	18.26

V becomes a maximum at 105.4 ft. per second = 6324 ft. per minute.

In Tables III. and IV., the angle of Subtension, @, is taken at 180°;

Should it be	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°	200°
Multiply above values by	.65	.70	.75	.79	.83	.87	.91	.94	.97	1.	1.05

THE MANUFACTURE OF LEATHER.

EAST INDIA and other kips are chiefly dressed for working men's boots. Leeds being a great center for currying as well as tanning them; they should, after well soaking, lie a day to supple, and the flesh be skived off clean, the butt parts having a cross shaving taken off, and the shanks and necks be reduced where necessary; they should then be rounded, the bellies being cut off the whole length, and the necks according to the growth of the pelt, and the kind of goods they are intended for, the remaining butt being cut into equal parts from tail to neck; the butt should then be well set out with stone or sleaker, so that every contraction is removed. Some curriers consider this work superfluous, and dispense with it; it is paid for as extra work, but it pays master and man to carry it out efficiently, as it aids the work that follows, and so extends the leather that in the next shaving so much less is required to be taken off; that the prevention of loss in weight more than recoups the wages, and secures foundation for pattern and quality that cannot be obtained if this part is neglected at this stage; they are then ready for flatting, that is, a light shaving with a low, fine edge lengthways, to procure a level surface. The bellies and shoulders may require a final shaving to level the sides and shanks, and they all should be well set out *before* scouring, which should be like other goods well done, and the sumacking and sleaking out also. Almost all curriers practice setting out firm on the grain on the stuffing table, and some also summing or part drying previous to stuffing; Jackson Schultz even advocates it, but summing prevents the leather from receiving a fair quantity of dubbing, and setting in this state shuts down the fibers and has the tendency to harden. For all upper leather that is for waxing, I would strenuously advise that it be only laid on the table to be oiled on the grain, or with thin dubbing, then sleaked *lightly* on the flesh and stuffed as needed; for kips as for shoe butts the dubbing made with pure sod oil is preferable, but the difficulty in getting good sod oil is so great, it has gone much out of use. The offal if dressed for black grain should be stuffed and finished as directed for cordovan, if for memel as directed for memel shoulders, and if for levant or enamel the particulars will be given under that class of goods; Kip butts should lie a few weeks when dry before finishing, and if well set out on the grain before removing the grease from the flesh, it is an improvement upon the old plan of bruising, the whitening is facilitated and less may be taken off; this not only leaves more weight, but a finer flesh when waxed; after whitening sleak very clean on the grain, and board up the kind of grain required.

Calf Skins—I would impress upon manufacturers the necessity of giving special attention to, as there is a large field for improvement in these goods, and for want of care the continental tanners and curriers have supplanted us in curried calf. This ought not to be, and need not be, if tanners and curriers will work together. The lines must be shifted a little. I will not go over the particulars of shaving, but I must on setting. I know the difficulty of getting what men call new-fangled ideas carried out, but I know if this part is done old style, you will get old style goods. The calf skin should be laid on the table, half the tail at the edge and two-thirds the neck, set down the back to the neck, and work from neck out toward the belly, following to butt and the stout part of shanks, working any fullness there may into the thin parts; then reverse the skin, again putting two-thirds the neck on the table, and set the same as the first half. This will give pattern, and present a surface for flatting, that will require but the little irregularities being taken off, thus saving much weight, and retaining better quality. The skin should be placed in the same positions in scouring and in stuffing, and when finished it will lie perfectly flat, and the flanks be more full and firm. sumacking as previously described, and sleaking out firm; they should not be summed, but stuffed as directed for kips, excepting sod oil, which

would make them fuzzy, and should have dubbing less in proportion as the color is required brighter, and should be light enough to take a light tallowing on the grain when dry, before making up for whitening as directed for kips.

By adopting the above mode in currying calf, an approach to continental will be produced, but to procure equal appearance to French, the tanner must adopt new modes of preparing skins for tanning, and if lime is still used, they must not lie half the stereotyped time in it, and must not be partly decomposed by excrement.

Memel calf is prepared in the same way in shaving, setting, and scouring, but in stuffing requires more care, that no dubbing get on the grain side for reasons stated in cordovan dressing, but should be oiled on the grain and stuffed fairly on the flesh, the blacking being done as soon as dry, then clear oiled and grained before drying in seasoning, and afterward lightly sleaking on flesh side to lie flat and clean, when dry they may be whitened after lying a few days, then trim the edges, regrain them, glass them lightly on the flesh, and finish on the grain with oil of beeswax.

Satin calf should be very carefully shaved to get a level substance; also extremely well set, scoured, sumacked, and sleaked out as other calf, but heavier stuffed, keeping the grain free from dubbing, seasoned and blacked as described for satin horse, and finished in the same way.

Porpoise hides intended for boot uppers are dressed in the same way as other leather for waxing, but are rather more troublesome in setting to get them flat, though they are free from contractions on the grain; they should be fairly stuffed and whitened, but are not generally grained; they are waxed in the usual way, and for laces are set as straight as possible, and not stuffed so heavy.

Calf skins for roller leather are made from very light skins of good grain; they should be from a mild, soft tannage, shaved very thin and level, set out very carefully, scoured on flesh and grain very clean, be put into clean warm water after scouring, and again sleaked out, then have an extra good sumacking, and hang up to summ, when they should be wiped over with an oily rag and set out firm, and when dry be passed under a heavy smooth roller; if required of any particular color, they may be stained after summing before the light oiling, and the quality will be equal to any that can be produced.

Welsh sheep skins, of which roller leather is made, they being the most suitable from the peculiarities of growth. Mountain breed and feeding conduce to firmness and solidity of the pelt, and only those from sheep slaughtered from September to March are of condition for this purpose; they should be dressed in the same way as calf roller leather, except the oiling.

Dog skins are not tanned or curried in large quantities, but they make very choice leather for superior boots, and are very suitable for tender feet, and are very durable. The currying is very simple, requiring only sufficient shaving to remove the flesh, then scour as for other goods; sumac and stuff very light; season, black, and grain, either straight or cross as memel; oil on the grain very lightly to strike the black, and they are ready for the bootmaker.

Goat skins for black memel should be dressed in the same way, but large quantities are dressed by jobbing curriers, who merely soak them, sleak them out, and when dry black them, grain them, and oil over; and when redried board them up, and they are finished.—*London Tanners' and Curriers' Journal.*

VETERAN CARPET PATTERNS.

The praises of "old books, old wines, old shoes, old friends," have been rehearsed in pleasant prose by one of the gossipy writers of our day. How old a shoe must be to reach its highest perfection has never yet been settled; but there must be a limit somewhere to its usefulness. Even of a favorite shoe and its wearer, it must be true that even the best of friends must some time part.

On the other hand, there seem to be no bounds to the usefulness of some carpet patterns. Age cannot wither nor custom stale their infinite variety, and they reel off the loom year after year, as fresh and vigorous apparently as when they first set out on their voyage of life half a century ago.

Portraits of two of these gray-haired veterans confront the reader from these pages, each contesting for the honor of being the oldest carpet that has ever been continuously in use in this country. It is probable, however, that the Lowell No. 441 is entitled to the distinction, from the fact that its origin is lost in the mists of antiquity. Where it came from no one apparently knows; but it is certain that, early in the history of the Lowell Company, it was stolen, like all early American patterns, not to say a good many later ones, from England, or rather Scotland. It is known as the "Eagle pattern," and has always been made in scarlet and green. Everybody in the trade has seen its familiar face, and every now and then it is ordered into loom, for there is a constant call for it in the goods of various makers. In fact, it is said that for years it has been "private" to four firms in Pittsburg. "What is the number of the Lowell Company's 'Eagle pattern?'" the writer asked Walter Shaw one day. "441, color 587 Y," was the prompt response, although it is fourteen years since as a boy he used to show it to the customers of the house.

"You know," he added, "the color number in those days used to express the actual colors of a carpet, Y in this case being added to indicate a certain peculiar shade of green."

Of about the same age as the "Eagle pattern" is the Hartford Company's 6,042, although the origin of this is involved in less doubt.

Mr. Reune Martin relates that, when he came to the Hartford Company, in 1844, Mr. Orrin Thompson told him that he had ordered the pattern out of work some years before, but it was again put in loom, and has been selling ever since. It was designed, Mr. Martin adds, by Thomas Barclay, of Glasgow, who died only a few years ago. Later on, when American manufacturers began to use original designs, Mr. Barclay sold many patterns to the Hartford Company. No. 6,042 is also made in scarlet and green.

It would be interesting to inquire what has given such extraordinary life to these two carpets. Possibly the early popularity of the "Eagle pattern" may be attributed to its fancied resemblance to the national emblem; but so far as any patriotic admiration for the proud bird of freedom as a feature in carpet design is concerned, a quail on toast would to day, doubtless, possess much better selling qualities.

In the case of the Hartford carpet, not even a patriotic ground of popularity can be assumed, and the causes of its long success must be looked for elsewhere. Such speculations, however, are foreign to our present purpose, which is merely to call attention to a few of the oldest and most widely known of American ingrains. "What songs the sirens sung," says Sir Thomas Browne, "or what dress Achilles assumed when he hid himself among women, though difficult matters, are not beyond all conjecture;" and it is possible that some of our readers who have sold these two carpets over and over again, may be able to tell why it is that they hold their

THE EAGLE PATTERN.

own in the teeth of the wonderful improvements that have been of late years made in the manufacture of two-ply goods.

The popularity of the "Henry Clay," another of the famous patterns, is less difficult to account for. Probably more of it has been made and sold than of any ten other ingrains ever made in the United States. At one time everybody

HARTFORD PATTERN No. 6,042.

who could make an ingrain had it in loom, and it was produced in every class of goods, from the best standard extra-super down to a grade which could be sold either for carpets or for fish nets. It was adapted to various styles of coloring, and was brought out in many shadings. It was a point figure, turned right around and matched, was of moderate size, and altogether had many elements of success. It took its name from the fact that when Henry Clay visited New York during the time of his presidential aspirations, it happened to be selected to lay down from his carriage to the entrance of the Astor House, where he stopped.

The "Sailor" pattern, as it was called at the mill, or the "Rope," as it was known to the trade, was one of the greatest successes the Lowell Company ever had. Being a one-thread cumber, and this company at that time owning the only looms in the country on which it could be woven, they had it all to themselves, and found it very profitable. It was, we believe, designed by Ney, and consisted of a diamond formed by a rope.

At one time the same company ran twenty-eight out of sixty-three looms on 3,628, which was made in seven or eight colors. After the patent ran out the pattern was taken up by a number of other manufacturers. It may be added that at that time anything in the shape of a carpet would sell, no matter what the design.

Moreover, this has been beaten in later days by Stephen Sanford's 1 300 three-ply, on which he at one time ran twenty out of thirty-four looms. The carpet was ordered into work so late as last year by Walter Brothers.

These instances of unusual or prolonged success in patterns might be multiplied indefinitely, as the "Grape Vine" in tapestry ingrains, and an eight-and-a-half pair carpet which Daniel Curry is making for Keveney & Co., and which is copied from a three-ply made by Hugh Wilson of Kilmarnock, and brought here by the late William Sloane. But enough has been quoted to show how difficult it is to formulate any set of rules by which to decide what will or will not be a successful design.—*Carpet Trade Review.*

WASHING WOOL AND ITS LOSS IN WEIGHT.

By W. J. MENZIES.

SOME statistics and particulars of losses in weight in washing greasy wool of different descriptions, which were carefully taken during the late Wool and Woolen Exhibition at the Crystal Palace, will doubtless be of interest to many woolen manufacturers. In washing wool the point that should be specially considered by all wool and worsted spinners is to thoroughly cleanse it for spinning and the subsequent dyeing operations, and yet with the smallest loss of weight that is possible. Woolen yarns are generally actually sold by weight, and the value of the finished goods afterwards is practically, also, to a large extent, governed by their weight. To wash or dissolve away therefore from the actual fiber of the wool more than is necessary is undoubtedly a loss to the woolen manufacturer. There is, besides, not merely the question of the actual loss in weight, but also the depreciation in the value of the wool, owing to its fiber being weakened and partly destroyed by violent and unnecessary scouring, which has, at the same time, caused the loss in weight. Many manufacturers by no means give so close attention to the best means of cleansing their wool that this subject deserves. It seems to be thought merely a preliminary operation, and quite a secondary consideration to the spinning and weaving that follow. The wool has to be cleansed somehow, and it is done in the cheapest manner possible, by scouring with soda-ash or a strongly alkaline soap! Now, nothing could be more objectionable than this mode of procedure. Not only is the dirt removed from the wool, and every trace of the lubricant that nature has placed in it taken away, but actually part of the substance of the wool itself is dissolved. Woolen manufacturers who thus treat their wool cannot generally be aware that not only can the wool be cleansed with a strong alkaline solution, but it only requires time and a little extra heat to dissolve it altogether. The practical result is this: In order to save a small quantity of potash soap, which can easily be made at a cost of about 2d. per pound, an appreciable weight of clean wool, of about an average value of 2s. per pound, is dissolved and washed away! In other words, a very penny-wise and pound-foolish course is adopted. It is therefore clear that neither soda ash nor a strongly alkaline soap should be used for washing wool, but a neutral potash soap only be employed—that is to say, a soap containing no excess of free alkali. Of course, more soap will be necessary if it is neutral, but this is much more than counterbalanced in the gain in weight on the washed wool. A potash soap should be used, as nature uses potash, to the exclusion of soda, in the composition of the "grease" or "yolk" on the wool when growing in its natural state. What can be accomplished in washing with a perfectly neutral potash soap was well exemplified at the recent wool exhibition by the Greenbank Alkali Company, St. Helens, with a soap made on the spot for the use of the wool washing machines, by the simple admixture of pure caustic potash and tallow or cotton-seed oil by the cold process. Beyond the mere handle and appearance of the wool after washing, a series of experiments were conducted in the following manner, with this pure neutral potash soap, in one of the large wool-washing machines, which was put at their disposal for this purpose. It was determined to wash a parcel of Sydney, Port Philip, and New Zealand wool, carefully noting the weight of the wool before and after washing, and obtaining a close valuation in each case of the greasy and washed wool, which was kindly undertaken by one of the most eminent firms of London wool-brokers, without their previously knowing the actual loss in weight. This valuation was then in each case worked out in conjunction with the loss in weight, with the following result. The figures have been reduced to percentages for the convenience of calculation. Sydney wool, 100 lb., valued in the grease at 11½d. per pound, gave 48½ lb. of clean wool, valued at 26d. per pound, or after deducting a loss in weight of 51½ lb., showed an increase in actual value of about 10 per cent. Port Philip wool, 100 lb., valued in the grease at 11½d. per pound, gave 49½ lb. of clean wool, valued at 27d. per pound, or, after deducting 50½ lb. loss in weight, showed an increase in value of about 16 per cent. New Zealand wool, 100 lb., valued in the grease at 12½d. per pound, gave 56 lb. of clean wool, valued at 25d. per pound, or, after deducting 44 lb. loss in weight, showed an increase in value of about 12 per cent. The quantity of neutral potash used in each case was about 5 lb. per 100 lb. of greasy wool washed, which, if taken at a cost of about 2d. per pound, would amount to 10d., or say 1 per cent. on the value of the wool. Taking the labor in washing and drying at about the same, the clear gain shown, by washing in the best manner amounted on an average to 10 per cent. on the value of the wool. To a certain extent the fine handle and loftiness of the wool told in its favor, but it was evident that the chief gain had been accomplished in the abnormally small loss in weight, as every

manufacturer, on being shown the corresponding samples of washed and unwashed wool, estimated the loss in weight greater than it actually proved to be. This practical illustration will doubtless prove better to woolen manufacturers the gain in washing wool in a rational manner than anything else. If soda-ash had been employed, instead of the 5 lb. of neutral potash soap, made from pure caustic potash and cotton-seed oil, costing about 10d., the saving would probably have been half this amount; but on the other hand, the loss in wool would probably have been 5 lb. of washed wool, valued in London at 10s. The subject, therefore, of wool-washing, from a scientific as well as a practical point of view, will well repay the time devoted to it on the part of the woolen manufacturer or worsted spinner.—*Textile Manufacturer.*

DAMPING MACHINE FOR TEXTILES.

IN the finishing of cotton, woolen, and other textiles it is frequently necessary to damp them to a certain extent. The common machine for this purpose consists of a cylindrical brush, which, revolving rapidly and dipping somewhat at its lower side into a cistern of water, lifts up some of it and projects it in the form of spray on the cloth which passes above the brush. It is a matter of some importance that the damping should be properly done—that is, the desired quantity of water should be thrown on the cloth, it should be evenly distributed, and also its amount should be capable of easy regulation. Mr. Fromm, the inventor of the apparatus we are about to notice, under the impression that, in the brush and other machines, these desiderata are not obtained in a perfect manner, has accordingly designed the machine we represent in the annexed illustrations, which certainly contains several features that make it worthy of notice.

Fig. 1 gives a general view of the machine. The cloth is unrolled off the beam, E, and is finally wound upon the beam, G, by the surface roller, H, upon which rests another roller, J. These two rollers draw the cloth off the beam, E, and cause it to wind upon G in a manner that will be easily understood. The damping part of the arrangement consists of a copper roller, B, that just dips below the surface of the water contained in a shallow tank supported upon the frame of the machine. The roller, B, is tinned, and contains on its

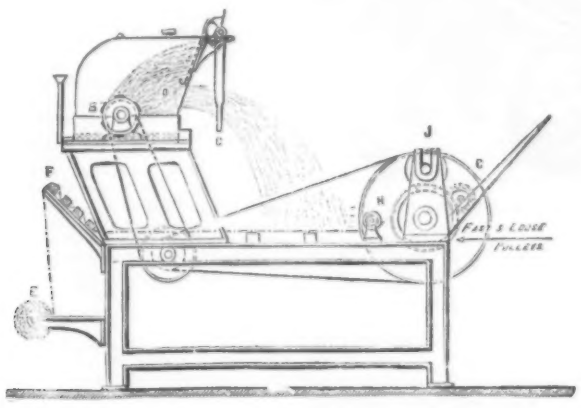


FIG. 1.

surface six lips or buckets, *a*, that pick up the water. This will be best understood by a reference to Fig. 2, which represents a section of the roller. The outer faces of the buckets are perforated with small holes, about the size of a pin, and therefore, as the roller is driven rather rapidly—about 300 revolutions per minute, by the belting shown—the water is, by the centrifugal force, projected out of the buckets through the perforations, and is consequently broken into a fine spray. This spray reaches the cloth in the direction clearly shown in Fig. 1, but after leaving the roller it is still further equalized and broken up into a fine state of division by being projected through a fine screen (A, in Fig. 2), made of bolting cloth, which forms the right-hand side of the hood or casing that covers the cistern. One of the advantages claimed for this machine is the ease with which the damping may be regulated. This may be done either by adjusting the level of the water in the cistern, or

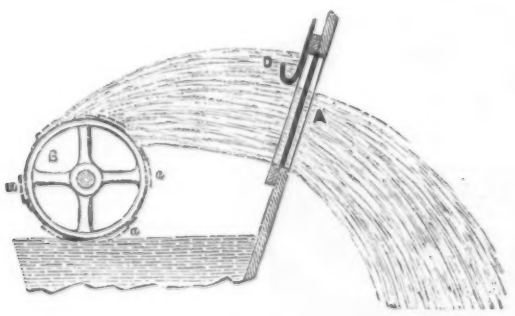
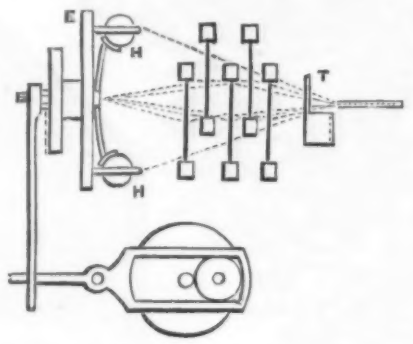


FIG 2

by raising or lowering a kind of slide or shutter, D, placed in front, or inside of the screen, A, which cuts off a part of the spray in the way shown, so that it passes through the fine screen. The position of the shutter is altered by the handle, C. Another feature worthy of notice is the uniformity of damping, both across the cloth and lengthways, and of course with a roller accurately made it cannot be otherwise. As regards accuracy, a comparison with a brush roller is certainly in favor of the turned copper roller used in this machine. If applied to some forms of existing machines, this arrangement may be expected to result in improved working, and by its addition to others the machine can readily be made to damp two pieces simultaneously, the upper one on the top face and the lower on its bottom face. —*Textile Manufacturer.*

APPARATUS FOR MAKING STRONG SELVAGE.

THE ordinary way of strengthening the selvage of any cloth is to take the last ten or more ends of the warp of doubled yarn, or to insert four instead of two ends in a dent. In this way a good selvage is obtained by the formation of a tape along each side of the cloth. There are, however, often cases where it is impossible or difficult to make the selvage in this way, as, for instance, where the warp in itself is very close, and where the reed would have difficulty



in passing over double the number of ends, or in certain descriptions of cloth where the width of tape-like edge is an objection. To meet these cases a German manufacturer has applied to his looms an arrangement for forming a narrow cord like selvage, whose thickness can be regulated by the size of the yarn which is specially used for this purpose, independently of the warp.

Our illustration shows the arrangement in vertical section. On each side of the warp a plate, E, is placed, which contains two bobbins, H, with the yarn which is to be used for forming the selvage. From these bobbins the yarn passes outside the healds through the reed, T, and is beaten home by it. The plate, E, is in connection with a lever and tappet on the crank-shaft, so that it receives half a turn with each pick, or, as the case may be, every other pick. In this way these two threads are always caught by the weft, and are twisted round each other, thus forming a corded selvage. The arrangement is simple, but from its peculiar construction and position in the loom can only be of use in special cases.—*Textile Manufacturer.*

COLOR DESIGNS ON PAPER.

THE special notice of the student is called to the power which one color has over another by close contact, and particularly the power which the component part of a mixed color has over the mixed color itself. For instance, orange in contact with pure russet gives it a purple cast, making it to appear purple russet. The orange in this case develops the purple of the russet, and overpowers the component of orange by its intensity in contact. The same result may be found in every other instance of a similar contact of a mixed color and one of its components. Besides changing the mixed color, another novel and beautiful effect is produced by contact of a component: it imparts a brilliancy and fascination to the mixed color which many have been led to think resulted in some manner from the excellency of the color itself. This remark applies not merely to the color in a picture or design, but to dyed colors in cloth, where brilliancy of dyed colors is so important a matter. The question arises here how far the nimbus or halo thrown by the component color upon the mixed has to do with the peculiar fascination we have mentioned, and which is undoubtedly desired and sought after by every successful artist and proficient designer. In the case of russet and orange named, the orange undoubtedly throws a halo of blue over the purple of the russet, which it develops by close contact. When green and yellow are in contact, the yellow casts a halo of purple over the blue, which it develops. If we take purple with red in contact, a halo of green will be cast upon the blue developed. A touch of orange in contact with scarlet gives intense brilliancy, and a shade of orange has the same effect upon scarlet. In pursuit of this phase of brilliancy by contact, we might ring the changes upon all the colors that are in contact throughout the diagrams. It is sufficient, however, to draw the student's attention to the importance of testing by experiment the changes that arise in practice. Let us now see what further scope is given to the designer or artist by this power of placing components in juxtaposition. In the case of Sir F. Leighton's picture, the citrines are influenced by contact of orange and green, and these again respectively by contact of red and blue. So on with the purples of this picture. The manifestation of genius in the production of a great work of art, either as a picture or a design, is seen mainly

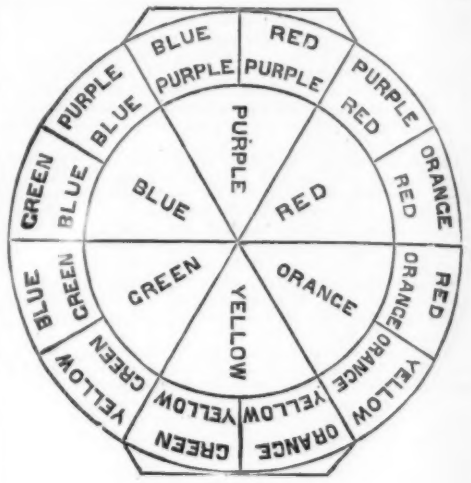


FIG 1

in the power of the artist to mass two harmonies of color in contrast, and the cunning by which he can develop the brilliancy and fascination of each color he uses by the law of juxtaposition of other colors, as just explained. But the first efforts of the student should be confined to simple studies, such as the introduction of a single thread of green or orange into or alongside one of the citrine shades that compose his harmony. As we cannot do more than indicate the scope and lines of inquiry, the student must make good the deficiency of illustration by practice and production of such himself. He should also produce the mixed colors, both secondary and tertiary, given in the diagrams, both on paper and in cloth. Beautiful mixed effects are obtainable by first laying a square of a color and ruling bars across it of the colors adjoining on either hand in the diagrams. For instance a blue green is made from a square of green with bars of blue. The pure blue, being transparent, becomes another green. To obtain the same effect in cloth, two greens must be used; the superadded one for the dyer may be got by covering a square of the green with a wash of the blue used for the bars. It is unnecessary to say more on this point, except that it is the best method by which to

Fig. 2.

observe and know the subtle effects arising out of contact of two colors, their joint influence, or influence in changing one another. The hair-line stripes in blue and black, etc., worn lately, illustrate what may be carried out indefinitely by working to the arrangement of colors in the diagrams such colors that are in juxtaposition.

In connection with designs generally, black, white, brown, and gray may be used with good effect, if carefully introduced. With the warm colors, yellow, red, citrine, and russet, brown and warm grays of a harmonizing nature with white are proper. With the cold colors, blue, purple, green, and olive, black, pure gray, and white may be harmonized. The introduction of black, brown, gray, and white extensively, or as the basis of designs, is a very important matter when designing patterns for the low woolen trade—in fact, for the Yorkshire trade generally. But till the student has mastered the theory and practice of coloring, as just laid down, and feels that the mist and uncertainty which surround his ideas of color have been thoroughly dispelled, we should advise him not to attempt designs of the better class. He should work at first with

pure colors and tints and shades of the same, put together in simple designs, so as gradually to embrace the first principles of color, and then advance to more complex designs, according as he finds that he can introduce the results of subtler observation and practice. The marked want of success in the production of neat designs in very low goods is attributable to a great extent to a want of knowledge and experience in combining colors according to the laws and relations we have indicated. Apart from the demands of any special department of trade, the student must master these relations of color to one another in imaginary designs. To one wishing at once to apply colors in a manufacturing process, this course may seem roundabout and slow; but it will enable the apprentice ultimately to work with confidence and avoid loss in the manufacture of goods. In order to prevent any misconception of the diagrams (Nos. 1 and 2, which we reproduce from our last issue), we will give the relations of contrast and harmony, which are based upon the primary, secondary, and tertiary colors. Just as the relations between yellow and purple in No. 1 diagram and those between citrine and purple in No. 2 diagram were combined in the text relations, so we shall combine the red and green relations of No. 1 diagram and the green and russet relations of No. 2, and so on with the blue and olive relations which have orange in contrast:

HARMONY: Reds and russets.
CONTRAST: Greens.

No. 1 DIAGRAM.	Purple Red...	=	....Yellow Green.
	Orange Red...		....Blue Green.
	Red		....Pure Green.
No. 2 DIAGRAM.	Russet		....Pure Green.
	Orange Russet.		....Olive Green.
	Purple Russet.		....Citrine Green.

HARMONY: Blues and Olives.
CONTRAST: Oranges.

No. 1 DIAGRAM.	Purple Blue...	=	...Yellow Orange.
	Green Blue....		...Red Orange.
	Pure Blue.....		....Pure Orange.
No. 2 DIAGRAM.	Pure Olive....		... Pure Orange.
	Green Olive...		....Russet Orange.
	Purple Olive..		...Citrine Orange.

The law of repetition has been mentioned as one to be observed in designing. In art generally it is made to play a great part. Why the number three should stand so prominently to the front in this connection is a question worthy a disquisition by some master mind. In colors we have the three primary, the three secondary, and the three tertiary, and we have also three great relations of harmony and contrast among colors, as shown in the diagrams now introduced. In sculpture we find the three graces; in painting the three goddesses. The favorite division of a drama is into three acts; artists almost invariably group their figures in threes; and in design the attempt should be made by the student to conform as far as possible to this number in the repetition of figures and colors. In each of the three relations given above we have three colors—in the first, yellow, citrine, and purple; in the second, red, russet, and green; in the third, blue, olive, and orange. It will now, however, be better perhaps for the student to put in practice the rules and suggestions already given, as a lengthened exposition without the aid of colored designs for illustration of the text might become tedious and complex.—*Textile Manufacturer.*

DRY PLATES FOR TRANSPARENCIES.

WITH regard to exposure: much will, of course, depend upon circumstances; but it may be taken as a general rule that a full exposure, and slow, well restrained development will give the best results. As an example of what may be done in correcting abnormally-long exposures by suitable development, we may note that the charming collodio-bromide slides exhibited by Mr. John Nesbit at the recent meeting of the Amateur Field Club, were many of them exposed in the camera the whole of a winter's day, when ten minutes or a quarter of an hour would have sufficed. The results were perfect, and though this is unnecessarily straining a point, it proves the flexibility of the manipulations.

With regard to the development: we should call the attention of those of our readers who are familiar only with the *gelatine* dry plates, that dry collodion plates differ very greatly in the mode of development they require. The chief point to be borne in mind is that they will not stand the application of nearly so large a quantity of ammonia. The quantity, or rather the strength of ammonia used to *start* a gelatine plate would hopelessly ruin most collodion ones. Another point in which the development differs is in the absence of the necessity for a dish in which to perform the operation, as well as of any tendency on the part of the film to stain or discolor from prolonged contact with the developing solution. Further than this, a much more comfortable light is allowable than with gelatine plates, and the progress of the development may be accurately estimated by examining the plate by transmitted light.

The solutions required are as follows:

A.

Liquor ammonia, s.g. 0·880	1 drachm.
Bromide of potassum.....	20 grains.
Water.....	1 ounce.

B.

Pyro	grains.
Water.....	1 ounce.

In addition to these a mixture of methylated alcohol and water, in the proportion of two to one, and a plain solution of ammonia 1:8, and bromide of potassum thirty grains to the ounce, should be kept.

Before commencing to develop, the plate is placed upon a pneumatic holder or leveling stand, and the dilute alcohol poured on in sufficient quantity to cover it. This flows as easily as collodion, and is returned to the bottle and employed over and over again, its only use being to prepare the film to receive the developer. Should the wash of alcohol be omitted the image will be, in all probability, extremely thin and poor, owing to the inability of the developing solution to penetrate the pores of the collodion film. The plate is next placed in water to soak, or rinsed under the tap until the water flows evenly from its surface, when it is ready for development. Pour into a developing glass a sufficient quantity of solution B to cover the plate comfortably, and having taken the latter on a pneumatic holder, flood it with the pyro solution. Now drop into the cup one minim of A for each drachm of solution, mix with the pyro, and return it to the plate, which should be kept gently in motion until the image commences to appear. This will take probably a minute. The progress of the development must be carefully watched, and if all go well a beautifully-delicate picture will make its appearance, showing perfectly as a positive by reflected light, but possessing little or no density when examined by transparence. Watch for the finer details of the lights, and when these appear pour off the developer into the cup, add to it a similar quantity of A to that employed at first, and again return to the plate. This will immediately cause the image to gain density, and generally with such rapidity that it is necessary to watch very carefully for the proper moment to stop the action. If insufficient density be obtained in this manner a few drops more of the ammonia solution may be used; but great care should be observed to avoid fogging the plate or causing an appearance resembling solarization.

If from under exposure the first addition of ammonia fail in bringing out the details, a drop or two of plain ammonia solution will be required, while if the development proceed too rapidly more potassium bromide will be necessary. When the development is complete the plate presents a beautifully delicate appearance by reflected light—quite different from a gelatine plate. The shadows are of a pinkish purple-brown color, with a peculiar bloom resembling that of a bath plate under the most favorable conditions, while the lights, if pure, are represented by the opalescent bluish-white tint of the unreduced bromide. By transmitted light the effect is totally different, a clear vigorous image being shown.

It may happen that, from error in exposure or other cause, there may be a lack of intensity, in which case a touch of pyro and silver will improve matters. If there be a general lack of force, though the gradations of the image are correct, the intensification should be performed before fixing. If there be a flatness or want of contrast it will be better to fix first. Except in cases where it is intended to intensify subsequently the fixing agent should be weak hypo.

The intensification is performed with solution of pyro, one and a half grain to the ounce, to which a few drops of the following are added:

Nitrate of silver	30 grains.
Citric acid...	20 "
Nitric acid.....	10 minims.
Water	1 ounce.

Be careful not to use this too freely, or a coarse image and a bad color will be the result; but by proceeding slowly very rich brown tones may be secured, as well as the desired "sparkle" and pluck. One or two drops of the above to each drachm of pyro solution will suffice to commence with, and a little more can be added as the intensifier colors.

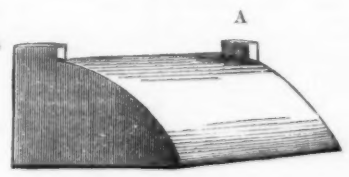
If sulphate of quinine be used in the emulsion the tone of the resulting transparencies—unless under exposed—will generally be satisfactory. Great variety of tone may be produced by varying the exposure, and also by adding to the alkaline developer small quantities of a saturated solution of acetate, phosphate, or tungstate of soda, or ferrocyanide of potassum. Ferrous oxalate gives black tones, but these are generally considered too cold for lantern work. —*British Journal of Photography.*

COATING PAPER WITH GELATINO-CHLORIDE OR BROMIDE.

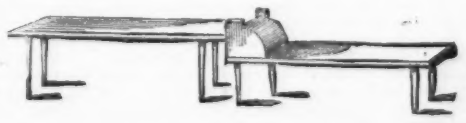
BY T. G. WHAITE.

To successfully cover a large surface of paper with gelatine emulsion in a fluid state will be found by most operators a very difficult proceeding; the irregular expansion and cockling of the paper when the warm emulsion is applied, and the rapid setting in pools and waves, make it almost, if not quite impossible to obtain a sufficiently level and evenly coated surface for printing by contact, especially if the smallest piece of the margin should escape coating, which is very likely to be the case, working, as we do, in so dim a light, and with such an obstinate and ill-flowing a medium as gelatine emulsion.

After trying numerous methods with varying success, it occurred to me to try coating the paper with a cold and "set" emulsion; this I find to answer perfectly, leaving nothing to be desired, the apparatus required being exceedingly simple and inexpensive. It consists of a hot water reservoir, as per diagram, made of zinc. It is open at top of the two small projecting pieces, A A. The hot water is



poured in at these, and they act as cisterns to insure the complete filling of the reservoir, and moreover, serve as guides, keeping the paper between them in its passage over the heated surface. The back, ends, and base should be covered with felt. It will then be unnecessary to have any light burning under it, as the once filling with boiling water will be sufficient for three or four hundred feet of paper. At the back and top of this apparatus a leveled bench is placed, say twenty-four inches wide, and the desired length, a little less than half the length of the room, say eight or ten feet, and in front of the reservoir another bench the same length, the upper one for leveling and setting on, the lower one for coating, placed thus:



Suppose the paper used for carbon tissue be selected twenty-two inches wide and cut in eight or ten foot lengths —a convenient size to handle—place one of these on lower bench, and with a stiff hog hair brush about eight inches wide, something like a small whitewash brush, take the cold emulsion either in lumps or after being squeezed through Berlin canvas (I prefer it in lumps), and work it with the brush all over the paper, as a paper-hanger would his paste; it very quickly gives way to a vigorous attack with the brush, and looks very smooth and free from lumps, even at this stage. Now take one end (having previously filled the cistern with boiling water), and steadily drag it from the lower bench to the upper one, between the two uprights A A of hot water cistern; the least contact with the zinc is sufficient to flow it, and it again sets almost as soon as it reaches the leveled bench; it may now be left there until another sheet is covered with the cold emulsion, and then hung up to dry in a cool draught. If it be thought desirable, a second coat can be applied, but this I have not found necessary.

Should a very thick and glossy surface be desired, it may be found necessary to reduce the proportions of gelatine to the chloride or bromide; a much larger proportion of the sensitive salt can then be applied to the paper.

One word of caution: do not let the sheet *remain* still for an instant in contact with the heated surface; a steady drag over is quite sufficient to break down the now well divided up jelly; the least hesitation or prolonged contact will denude it of some portion of the emulsion, and make wavy lines like those we find on ill-prepared albumen paper.—*Photographic News.*

NEW FORM OF ELECTRO MAGNET.

By PROF. FRED. ARZBERGER.

THE electro-magnet is now in so frequent use that a description of a new and simplified form of this apparatus is of a nature to prove interesting to the reader.

Such an arrangement is shown in the annexed figures, where M represents an elbowed piece of soft iron, to which is screwed a cylindrical core, E (also of soft iron), which carries a bobbin. The two brass plates, S S, screwed to the arm, M, carry the axis of oscillation, C, of the armature, A, which is connected by two screws to the lever, H.

Beneath this axis of oscillation, between A and M, there is a space of one to two millimeters to allow of the play of the armature, A, on its axis. Owing to the little distance which separates these parts, this electro-magnet acts like a horse-shoe magnet, although it is provided with but a *single* core and a *single* bobbin. Electro-magnets of this kind act with more force and possess the advantages of simplicity and cheapness.

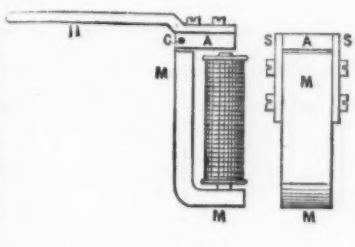


Fig. 1.

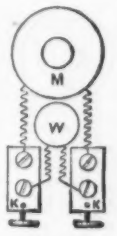


Fig. 2.

Attention is now called to a subject the practical importance of which will be at once evident.

The corrosion of contact points produces in many apparatus frequent troubles, especially when the contact cannot act very strongly.

I have had for the last twelve years an electric pendulum, working without interruption, to which there is adapted an instrument that I have called a discharging resistance coil. This apparatus is constructed as follows:

I take a piece of fine brass wire, covered with silk, and having six to eight times the induction resistance of the magnetizing bobbin, and first stretch it and then bend it in the middle in such a way as to form a double wire, in which, when a current passes, there develop two parallel currents of equal force, which are in immediate proximity and which meet one another. If this double wire be wound on a bobbin, an induction of the spirals cannot of itself be accompanied by any immediate result. This bobbin, then, produces no spark at the time of closing or interruption. As may be seen in Fig. 2, the magnetizing bobbin, M, and the discharging resistance bobbin, W, are connected with two clamps, KK, in such a way that the extra current discharges itself through W, thus preventing the production of a spark on contact. If, for example, W has six times the resistance of M, one-seventh of the total current will pass through W, and six-sevenths through M. There is, then, for the current a loss of one-seventh, which may be sacrificed in the majority of cases, when, by any means so simple, inexpensive, and occupying so little space, sparks occurring at the breaking of the current may be avoided.

ARRANGEMENTS FOR LIGHTING RESIDENCES OF W. H. VANDERBILT, ESQ.

THE magnificence of these dwellings has attracted so great attention, not only in this city but throughout the country, that we feel sure our readers will be especially interested in a description of the arrangements for lighting, water supply, drainage, heating, and ventilation.

A brief preliminary description of their situation, external appearance, etc., is prefixed for those of our readers who have not seen them.

They are situated on the west side of Fifth avenue, nearly opposite St. Patrick's Cathedral, about a third of a mile below Central Park, and occupy the whole length of the block between Fifty-first and Fifty-second streets. They are of brown stone, elaborately carved, three stories in height, beside a fourth lighted from a roof, and a basement (with no cellar). In external appearance the two houses are almost identical, but that on the corner of Fifty-first street is called the single house in distinction from that on the corner of Fifty-second street, called the double, which is designed for two families. The two parts of the latter house have no rooms in common (though they may be connected), and separate systems of drainage, water, and gas supply, so that so far as plumbing is concerned, there are really three houses. The single house is occupied by Mr. Vanderbilt himself, and the double by his sons-in-law, Messrs W. D. Sloane and Elliot F. Shepard.

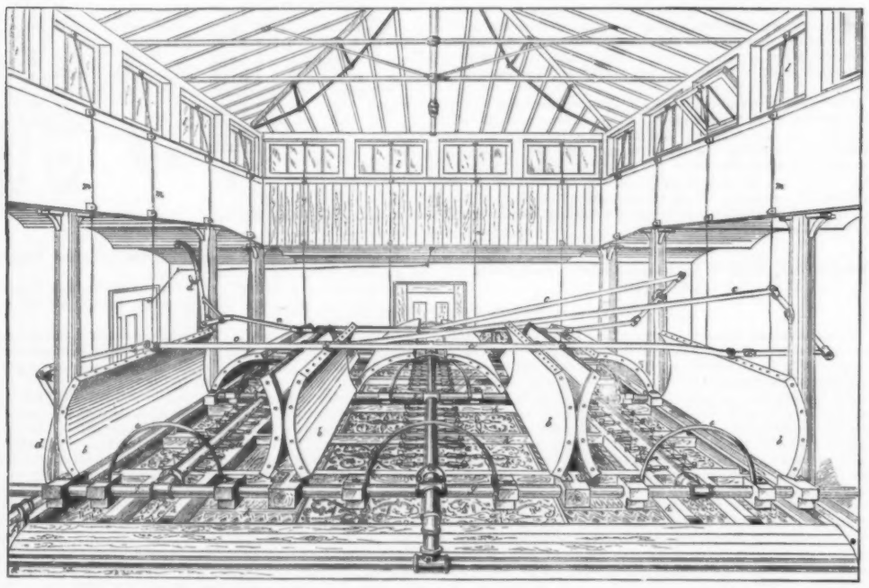
The main entrances to Mr. Vanderbilt's and Mr. Sloane's residences are on Fifty avenue, through a grand porch about thirty feet long, connecting the two houses, while that to Mr. Shepard's is on Fifty-second street.

We begin with the lighting apparatus in Mr. Vanderbilt's residence, which, as will appear, is very elaborate and extensive.

The gas fitting was done by Messrs. Robert Ennever &

Son, under the immediate direction of their foreman, Mr. G. H. Ord.

The pipes of three different companies enter the house, side by side (each 3 inches in diam.), so that in case one should fail, or for any other reason, two changes could be made from the one used at present. There are two "300-light" meters (reading to 10,000,000 cubic ft.), one for the picture galleries alone and the other for the rest of the house. They are so connected, however, that each can be used in place of the other, or the two combined. Condensation drip pipes are connected near the meters, but as the whole system is graded to the street main, it is expected these will not be needed. Beside the house meter are valves, with marked tags, controlling the supply to each floor—two for the first floor (one for the center, and one for the side lights), and one for each of the other floors. Besides these valves for controlling the supply to each floor, are others for turning on and at the same time lighting the gas (by electricity) in separate rooms or parts of rooms; as, for instance, four in a closet under the butler's pantry sink for lighting the burners on the different sides of the dining room, so that the light for that room may be from any one, two, three, or four sides; and in a closet off a rear passageway from the main hall, one for lighting the jets in the "dome" above the grand hall. A view of the interior of this lighting dome is shown in the illustration below. In the daytime the reflectors are raised to admit light through the glass roof, in the ridge of which is a long horizontal ventilator, opened and closed by a system of levers, immediately below, operated by a chain. There are also transom-windows (*l l*), for ventilation, all around under the eaves, opened by cords. There are 192 jets under the reflectors in this dome. Inside the hall are about 300 more, 68 being in the upper part on the pillars, and the remainder on the wall below. The two picture galleries are lighted from above in the same way, by reflectors through stained glass ceilings. The large gallery has 368 burners in the dome for lighting the room in general, and 200 more inside, on a horizontal line of pipe suspended from the ceiling, running around the room some distance from the wall, specially for lighting the pictures. For the smaller gallery are 132 jets in the dome and 50 inside. In a closet at the entrance of the main gallery are five valves, one for turning on the gas from the gallery meter, another that



ARRANGEMENTS FOR LIGHTING RESIDENCES OF W. H. VANDERBILT, ESQ.

from the house meter, and the others for turning on and lighting all the burners of the two oil color galleries, and a smaller one for water colors.

All burners in the house are lighted by electricity, the larger collections by turning on the supply, and the isolated jets by separate attachments.

In all there are about 2,000 burners, and the estimated amount of pipe is about 15,000 ft., or nearly three miles.

Alongside of the gas pipes, going to every outlet, are electric light wires (insulated by rubber) from a dynamo run by an engine in a separate room in the basement, adjoining the furnace room. Lamps have been attached and the apparatus tried, but given up for the present, because making so much noise, and the lamps removed.

The next paper will be on the water supply, with a full page illustration.

EXPLANATION OF THE ILLUSTRATION.

The burners, *a a*, are lighted by electricity through wires from a distributer, *n*; *b b* are tin reflectors (on wrought iron frames) for throwing the light at night down through the stained glass, *k k*, supported by the floor beams, *h h*, of wood; *c c* are levers for raising and lowering the reflectors, by the handles, *d d*. When down, the reflectors rest on the semicircular iron hoops, *e e*, and when raised are held up by hooks on the handles, *d d*, grasping the pipes at the sides; *f* is one of the 2-inch supply pipes, serving also as supports for the apparatus; *g g* are also 2-inch pipes; *l l* are windows opened by the cords, *m m*, and hung on pivots above their centers, so that they close by their own weight when the cords are released.—*Sanitary Engineer.*

FALL OF BALD MOUNTAIN.—A large section of Bald Mountain, North Carolina, near Bakersville, is said to have fallen into the valley February 13. The rumbling noise preceding the crash was heard for miles. The cause of the fall is uncertain; probably the recent heavy rain and snow storms have had something to do with it. A smaller landslide, four years ago, gave rise to local fears of a volcanic eruption. The fallen part of the peak is described as a "slice half a mile square."

APPARATUS FOR LIGHTING GAS BURNERS.

THE characteristic feature of the new apparatus invented by Mr. Klinkerfuss, of Göttingen, for lighting gas burners consists in the use of a metallic thermometer, *m* (Figs. 1, 2, and 3), which becomes heated every time that the small auxiliary flame increases in size, and consequently dilates. These motions of the thermometer are transmitted by the arm, *b*, to a double ratchet, *c* (which is supported at the point, *o*, in such a way as to be able to revolve), and to the toothed wheel, H. The latter is connected with a valve, P, which, according to the new position determined by the rotation of the wheel, H, allows the gas to enter the burner, A, or permits of A being put in communication with pipes of different sizes, or, finally, shuts off the flow of gas. When the aperture for the admission of gas is open the principal burner lights at the same time as the auxiliary flame.

The lower part of the apparatus contains a compensator, which is designed to prevent the small flame from increasing as a consequence of a progressive increase of the pressure of gas, and disturbing the operations of opening, closing, and regulating. This compensator consists of two chambers, B and D, which surround the tube of the burner, R, and are separated from each other by the partition, E. They are freely movable and are provided with a cap. In a normal state of things—that is to say, so long as no sudden increase of pressure of any importance occurs—the auxiliary flame consumes only the quantity of gas that is capable of passing through the small apertures, *r*, and there is thus produced a difference of pressure, which is almost constant, between the chambers, B and D. When the pressure of the gas increases suddenly, the excess of pressure in the chamber, D, is sufficiently strong to raise the partition, E, and to lift a cone, N, of rubber or other analogous material which surrounds the inner sides of the chamber, B. As soon as this occurs the large aperture, *s*, is rendered free, and the gas enters the auxiliary flame in greater quantity and increases it correspondingly.

In the second apparatus of Mr. Klinkerfuss (Figs. 4, 5, and 6) the upper part serves to light, regulate, and extinguish the principal burner; and the lower part, which is separated from the former by a plate, D, serves to annul

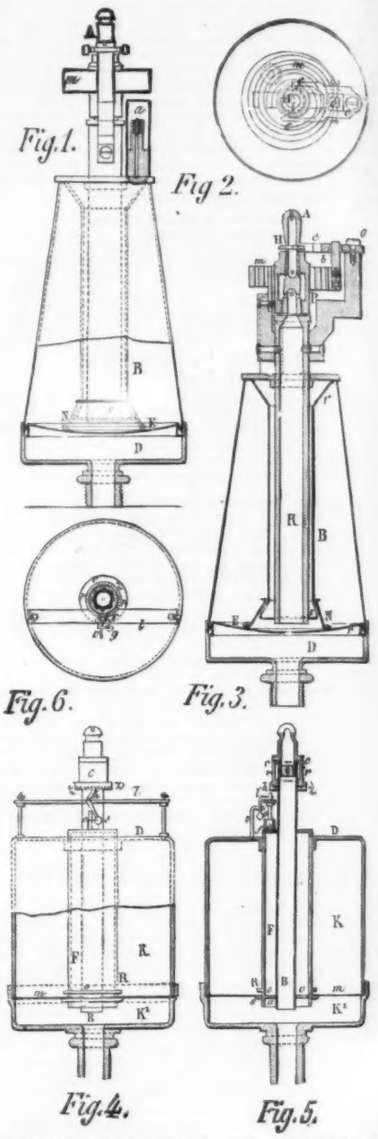


Fig. 1. Fig. 2. Fig. 6. Fig. 3.

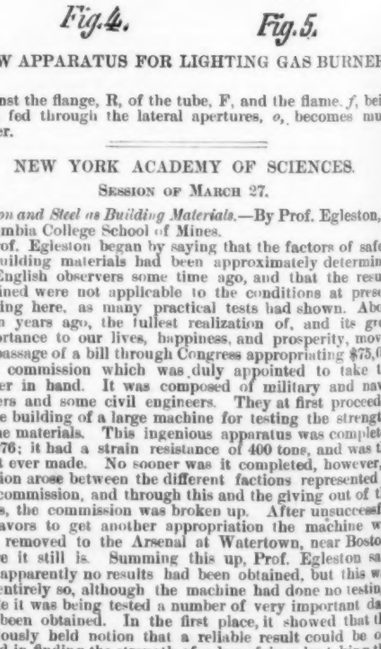


Fig. 4. Fig. 5.

NEW APPARATUS FOR LIGHTING GAS BURNERS.

the influence that accidental variations of pressure might have upon the upper part. A small flame, burning constantly at *f*, effects the lighting and constitutes the motive power that determines the motion necessary for opening and closing. When the pressure of the gas happens suddenly to increase, the small flame increases in a greater proportion than the other flames, because a new channel for the gas opens for it in the lower part of the apparatus. This flame then rises up as far as a narrow metallic strip, *l*. The mechanical action of the heat causes the latter to bend upward, so that the hook, *h*, affixed to it engages in the toothed wheel, *z*, and cannot be disengaged therefrom while rising, since its longer arm, provided with a counterpoise, *o*, is pressed against the rod, *v*. The crown wheel, *z*, then revolves, and with it, at the same time, the sleeve, *e*, which surrounds the burner tube. This sleeve is provided internally with grooves, *r*, which, in certain positions, coincide with the apertures of the tube, but in others do not. These grooves thus give passage to or cut off the access of gas to the principal flame, since the tube is closed at *i* between the upper and lower rows of apertures. When the motion is such that an opening takes place, the larger flame is lighted from the smaller. When the flame, *f*, diminishes again, the strip, *l*, cools and loses its curvature, and the hook descends, slipping as it does so over the posterior face of the contiguous tooth, and the arm, with its counterpoise, *o*, is raised above the rod, *v*, until the hook has passed the point of the tooth. The arm then falls again on the rod, through the action of the weight, so that when the pressure happens to increase anew, the wheel, *z*, can again advance one tooth. The regulation of the lighting and extinguishing may be effected by modifying the arrangement of the apertures of the burner tube and that of the grooves of the sleeve. A very simple arrangement, which presents some analogy with a dry regulator, is employed for annulling the influence that might be exerted by accidental variations of pressure. This part of the apparatus consists of a cylinder formed of two chambers, K and K_1. The first of these is traversed by two concentric tubes, B and F, the former of which constitutes the lower prolongation of the burner tube, and debouches into the second chamber through an open extremity; while the second communicates, in a normal state of things, with the chamber, K, only through a very small aperture, *a*, which allows the passage of the gas for the flame, *f*.

In any case of accidental variation of pressure, the latter may become very great and yet have no influence in increasing the size of the flame, *f*, because the membrane, *m*, which rests on the ring, *s*, continues to rest on the latter, owing to the fact that the same pressure gradually takes place in the chamber, K, as in the chamber, K_1. When the pressure becomes very small the membrane, *m*, is pressed against the flange, R, of the tube, F, and the flame, *f*, being then fed through the lateral apertures, *o*, becomes much larger.

NEW YORK ACADEMY OF SCIENCES.

SESSION OF MARCH 27.

Iron and Steel as Building Materials.—By Prof. Egleston, of Columbia College School of Mines.

Prof. Egleston began by saying that the factors of safety of building materials had been approximately determined by English observers some time ago, and that the results obtained were not applicable to the conditions at present existing here, as many practical tests had shown. About seven years ago, the fullest realization of, and its great importance to our lives, happiness, and prosperity, moved the passage of a bill through Congress appropriating $75,000 to a commission which was duly appointed to take the matter in hand. It was composed of military and naval officers and some civil engineers. They at first proceeded to the building of a large machine for testing the strengths of the materials. This ingenious apparatus was completed in 1876; it had a strain resistance of 400 tons, and was the finest ever made. No sooner was it completed, however, a division arose between the different factions represented in the commission, and through this and the giving out of the funds, the commission was broken up. After unsuccessful endeavors to get another appropriation the machine was then removed to the Arsenal at Watertown, near Boston, where it still is. Summing this up, Prof. Egleston said that apparently no results had been obtained, but this was not entirely so, although the machine had done no testing. While it was being tested a number of very important data had been obtained. In the first place, it showed that the previously held notion that a reliable result could be obtained in finding the strength of a bar of iron by taking the strength of one having an end area of one inch and using simple multiples to correspond with the larger bar; thus there was a great difference between the real and calculated strengths of our metal structures. He then spoke of the immense industry the production of iron and steel was, and gave a number of figures showing it. He spoke at some

length upon the dangers incurred in using fatigued metals in construction, which would ultimately give way and perhaps entail the loss of hundreds of lives. The idea, he says, at present in view, is to have a bill passed to appropriate the necessary amount; a commission appointed, consisting of mining, civil, and mechanical engineers, who, under different condition, from those of the other commission, thoroughly exhaust the matter by conclusive investigations.

MEETING, APRIL 8.

Psychological explanation of the Salem witchcraft excitement, and the practical lessons derived therefrom.—By Dr. Geo. M. Beard.

Dr. Beard gave a full history of the details of the excitement in Salem in 1648, and of the trials of the twenty persons there and twelve others in other places, and their execution. This, it is said, in relation to the half million who had been executed on the other side of the Atlantic, was comparatively small, but nevertheless sufficient to arouse all persons in this country and especially New England.

The theory held by the perpetrators of these excitements was that it was a treaty which a person had made with the devil which placed the person in his power. Through him were all the evidences shown of his existence, as when brought near a slightly demented person, known as afflicted children, they were thrown down in convulsions, or saw strange phenomena. Dr. Beard showed how easy this was provoked, and, as an illustration, had two boys with him whom he made in one case to fall down in convulsions on seeing Dr. Newberry, and the other one see a yellow bird on his head and a hawk at his feet. Dr. Beard showed how this was produced, by the easy picturing of these things on an unsound brain. Dr. Beard then discussed at considerable length the Guiteau, Whittaker, and other cases in this connection, and the responsibility of demented persons.

AMERICAN CHEMICAL SOCIETY.

SESSION OF APRIL 7.

On the estimation of copper.—By P. Casamajor.

The author discussed the great indistinctness of the end reaction of Pelouz's method—that is, of dissolving the copper in ammoniacal solution and titrating with sulphide of sodium until the discharge of the blue color. He then showed his process, which was of dissolving the alkaline tartrate solution of Fehling's solution, the copper salt, and then titrating this with sulphide of sodium when near the boiling point. The precipitate of sulphide of copper was agglomerated readily by stirring in presence of the alkaline tartrate. Mr. Casamajor went over the process with some of the members, and the end reaction was distinctly found. This method is also applicable with lead and just as accurate. Thus it is capable of varied determinations.

THE SECOND PAPER OF THE EVENING.

On the determination of tannic acid.—By Mr. Nelson H. Darton.

Mr. Darton's paper was to show the relative values of all the different processes of tannic acid determination. Half of the paper only was read, showing the inaccuracies in the use of Lowenthal's and Hammel's process. A few remarks were made upon it. T.

AN INVESTIGATION UPON THE VALUES OF THE VARIOUS METHODS USED IN THE DETERMINATION OF TANNIC ACID.*

By NELSON H. DARTON.

PART I.

THE question of which is the most accurate and at the same time convenient method of determining the values of the various tanning materials is a much vexed one, and it is because chemists generally seem to have such vague speculative ideas in regard to tannic acid, that it is with great difficulty that we can learn anything from the many researches that have been published, they being, as a rule, enshrouded with enigmas and complications, thus rendering them of little or no value in a practical consideration. Besides this, most of the papers have no originality, being, as a rule, repetitions of worn-out theories, pointing out the difficulties lying in the way of those investigations; in fact, chemists seem rather to avoid the subject of tannic acid, but are continually pointing to it and expending all their talent in this direction in trying to find different forms of tannic acid.

As the manufacture of leather has now become such an important industry, and its intellectual production necessitates a full knowledge and control of the values of the materials used for this, a proper method should be decided upon, but not without careful consideration of its trustworthiness, this paper being for that purpose.

Of late, in my intimate connection with the tanning industry, I have fully weighed these considerations, and having in vain sought out, through what has been already published, to find the method in view, have taken the matter in hand myself, although very busy otherwise, and have made as far as possible, with the means at hand, a thorough investigation, the results of which I will detail in this paper. Before I give them, however, I wish to have it distinctly understood that I do not doubt the accuracy of what Proctor and some others have written, but as they claim that they were not the best attainable, I claim that mine are, and thus some discordances, but as the other papers gave few figures or demonstration, these are few and will hardly bear consideration. The investigations were to determine the relative accuracy of the following methods: Lowenthal's modification of his old method; Hammel's skin and specific gravity processes; Carpeni's zinc method as modified by Barberi; the gelatine or Watt's process, highly refined; Allan's lead method, modified by Sanford, and my own method, a radical modification of Lowenthal's.

Before considering the investigations, I would like to state that every evidence that I can bring to bear shows that there exists but *one tannic acid*, that is as I define it, a peculiar organic principle, ten parts of which unite with six parts of the component parts of the skin by weight, to form sixteen parts of leather. It occurs in many different conditions in nature, but only as regards admixture with glucosides, so called, extractive and coloring matters, etc., with which chemists have confounded it, and thus the many formulas advanced and nearly as many different ones as there are materials containing it. So when I mention tannic acid throughout this paper, I refer to this principle in a state of absolute purity in the above relations to leather, which is the only practicable way as yet of expressing it. Subsidiarily I divide it in two classes: The first, gallo-tannic acid when associated with oak and hemlock bark, etc., and which from nutgalls we can obtain in a state of absolute purity, although I have also obtained it from oak bark so pure as to have the same formula as that from the nutgalls; but as I am here intruding upon the subjects of another subsequent paper, yet unfinished, to prove that there is but one tannic acid; then I consider another association, that is with gums—kino and catechu and rhatany root, etc., from whence the impure substance, the so-called catechu tannin, has been obtained. This mixture unites very peculiarly, owing to the peculiar extractive matter, etc., present, and from which as yet we have not separated the tannic acid so as to secure it. The reactions which distinguish them from the last is the tannate of copper; is somewhat soluble in ammonia solutions in which this before contaminating extractive matter, etc., is dissolved; and also the tannate of copper contains in this case some of this matter. This is, however, strictly peculiar to these materials. The tannic acid will in all cases, however, combine with the skin in the pure state, as I have readily shown, or at least, after the washing and scrubbing, which is positively necessary, as I will show below.

For the purpose of standardizing the numerous solutions to be used, an absolutely pure tannic acid in relation to leather formation and practical theory, as noticed above, was prepared and examined. In every respect it was prepared thus: A fair quantity of coarsely-ground Aleppo nutgalls was taken and treated with ether and water after the method of the U. S. P.

The product thus obtained was then thoroughly washed with absolute alcohol dissolved in absolutely pure ether, and this repeatedly agitated with water until all of the gallic and considerable of the tannic acids were abstracted. It was then separated from the ethereal solution by gentle evaporation and dried in a vacuum. It was then dissolved in 80 per cent. alcohol, this solution filtered, and from thus separated as above. After drying at a gentle heat in the air bath, and over sulphuric acid in a current of pure dry carbon dioxide, a portion was burned and twice yielded the proper formula. This whole treatment is necessary to obtain the pure tannin, as it frees it from the one coloring matter soluble in alcohol, the other soluble in ether alone. A solution of this was prepared containing two grammes to a liter; this solution was kept in a colored bottle and out of contact with the air by carbon dioxide, when not in use. For greater precaution, the bottles were placed in the dark; no change, however, occurred in their relation to the permanganate solution or oxalic acid.

Pure gallic acid from nutgalls was procured, carefully recrystallized, and obtained pure. A solution was made containing two grammes to a liter of water, and carefully kept. Pure English gelatine (Nelson's) was used after further purification, and a solution of it prepared immediately before use by dissolving 25 grammes to a liter of a 10 per cent. solution of sodium chloride.

The permanganate of potassium solution contained 1·5 grammes to a liter, and was frequently renewed during the investigations.

The acetate of lead solution for use in Allan's method contained a decinormal quantity of pure acetate of lead.

The solution of indigo carmine was prepared by dissolving three grammes of pure indigo carmine to a liter of water and boiling for some time. It was carefully kept airtight, and did not change its relation to the permanganate solution a fraction of a cubic millimeter.

The other solutions were all prepared extemporaneously with every care and precaution.

For the objects of the determinations decoctions were prepared of hemlock, oak and chestnut barks, Aleppo nutgalls, sumac leaves, and of the so-called catechu tannins of gums, catechu, kino and rhatany root. As they were all made under the same conditions, I will only detail the mode of extraction of the first and most important one, hemlock. To a liter of the decoction in view, 20 grammes of the coarsely-ground select inner bark of the hemlock was taken. This was extracted by carefully treating it with water in a current of carbon dioxide, allowing the decoction thus formed to cool, and then filtering through four thicknesses of filtering paper. A very small amount of dilute sulphuric acid was then added to the solution, and it was again filtered. The excess of acid is neutralized by adding just sufficient baryta water and the precipitate filtered off. The decoction was thus freed from much of the so-called extractive matter and elagic acid, formerly held in solution, and contained but little more than tannic and gallic acid. This decoction was preserved in small flasks with carbon dioxide. The solutions from the catechu, etc., were prepared and kept in a similar manner, but still retained considerable extraneous matter. These last solutions, I may add, are much less liable to change, owing to the peculiar principles present. Tannic acid, prepared from the solutions by a process used for the nutgalls, the pure tannin from the latter, and the contaminated from the former, had widely differing formulas, but, at the same time, very valuable ones, showing that the method must be varied to obtain the catechu tannins, so called, in a nearly pure solution like the others.

The preliminaries now being adjusted, we will consider the results of the researches, commencing with Lowenthal's new modification, published in Fresenius' "Zeitschrift," 1877, pp. 33-101. So much has been written in favor of this method by Proctor and others, that I would fain have examined it; but in working with it for only a few hours I immediately noticed discordances with its own and also with working results, and my control method, which I will detail further on.

Ten portions each of the different decoctions were taken, and the analysis conducted in strict accordance with Lowenthal's directions. For the avoidance of misunderstanding, I will detail my exact mode of procedure to obtain the results noticed as No. 1 of the hemlock on the table, with approximate figures, however, the same decoctions being used for each column throughout the table, to make the results comparable.

Twenty c. c. of the indigo solution was first titrated with the permanganate; it required exactly 8·4 c. c. The bulk of the solutions during the titration, which was conducted in a porcelain dish, was always kept equal; the volume decided upon was three-quarters of a liter. A fixed amount of dilute sulphuric acid was always present—10 c. c.

Ten c. c. of the standard tannic solution was then taken; 20 c. c. of indigo solution and the acid was then added, and these together titrated as before, requiring 13·7 c. c., which, less the 8·4 c. c. for the indigo present, = 5·3 c. c. for the tannin. In this connection the relation with oxalic acid was also ascertained.

The same operation was then repeated, using the same quantity of the decoction as of the tannin. Before, 15·3 c. c. were used, less 8·4 for the indigo, equals 6·9 c. c. for the decoction.

100 c. c. of the decoction was then taken, placed in a flask with 50 c. c. of the gelatine solution and 100 c. c. of a saturated sodium chloride solution containing besides, to a liter 25 c. c. of sulphuric and 50 c. c. of hydrochloric acids. Between the additions the mixture is well agitated. It was allowed to stand over night and a perfectly clear filtrate taken off the next morning. To save calculations and fulfill similar conditions as those above, 25 c. c. was taken, equaling 10 c. c. of the undiluted decoction. It was titrated as above, using 11·45 c. c. of permanganate, or 3·05 c. c. for the impurities, etc., titrated before and not tannin. Reducing the amount 6·9 c. c. by this deduction to 3·85 c. c., we have the equation—

5·3 c.c. : 3.85 c.c : : 2 grammes to a liter: x grammes to a liter

x=1·45 c.c. grammes to 20 grammes of bark, or 7·25 per cent., the value of the bark. In tannic acid this is, as I will show, lower than really is the case:

No.	20 G. to liter Hemlock.	20 G. Oak.	20 G. Chestnut.	5 G. Nut Galls.	10 G. Sumac.	5 G. Catechu.	2·5 G. Kino.	2 G. Rhatany.
1	7·25	7·40	6·00	52·5	13·5	47·0	82 0	
2	7·00	7 30	6 00	56·3	12 9	51·0	82·0	
3	7·30	7·45	6 10	54·2	12·9	48·0	83·0	
4	7·20	7·25	5·90	55 0	13·3	49·0	82·5	
5	7·25	7·00	6·30	55·5	13·1	48 0	81·3	
6	7·20	7·00	6·00	53·0	12 8	50·0	83·0	
7	6·90	7·10	5 90	55·6	13·2	51 0	82 0	
8	7·25	7·30	6·20	54·4	13·25	49 0	82·0	
9	7·10	7·20	8·00	54·5	12·95	50 0	83.0	
10	7·15	7·10	61·0	52 8	13 2	48·0	81·5	About.
Average.	7 16	7 21	6·15	54·4	13·1	49·0	82·1	80·00
Real value.	7·90	8·22	7 42	61·5	16·25	40·00	72·00	34·00

All these figures together, except those of the rhatany, give an average value of 100 per cent. nearly, but as this average is of the high and low, it is not to be taken as a value. The average from the first price is about 86 per cent., and for the last two 117 per cent., or a comparative value the same as the other. These errors are incurred thus: In the first place, the tannate of gelatine is more or less soluble in a weak gelatine solution, even when chloride of sodium and the strong acids are present; in fact, although the acids facilitate the coagulation of the precipitate, and, consequently, the subsequent filtration dissolves a portion of it. It is also somewhat soluble in solutions of gallic acid. This is also shown by the figures in the nutgall column; besides this, considerable gelatine remains in solution as an excess, and as the quantity is very variable, cannot be calculated for, as it depends upon the amount of so-called extractive matter present, as I will show further on. All these errors together produce a difference of 40 per cent. at least. This is, however, partly compensated by the amount of oxidizable matter and gallic acid, which are also, when together, precipitated partly, or in greater or less proportion, with the tannate of gelatine. Considerable is also precipitated by withdrawing the tannic acid, which, acting as a solvent, holds them in solution. This is shown, besides, in some experiments in the column under rhatany, where so much matter depending on the tannic acid for the solution was precipitated as to render this determination impracticable. It is also shown in catechu and kino, but to a less extent. This is what some in good faith call a peculiar tannic acid, and even separate and ascribe to it a formula. They probably never combined an ounce of tannic acid with as much skin to make leather in their lives, or they would have known its character. Thus their ignorance is pardonable. I have not endeavored to modify this process, in the last three determinations I used little excess of gelatine and acid; but with no perceptible difference. The real values were found by the control to be detailed further on.

This part of the method sureiy is a very satisfactory one, as far as it goes, as it is easy to execute, and has not so many of the difficulties peculiar to the others. It, however, does not come up to my working tests on a large scale, wishing to investigate further its value, especially on the use in determining the tannic acid in spent barks and liquors, those from which the so called *free* tannic acid has been removed by tanning with them.

These liquors contain many unknown principles derived from the skins and their treatment; and thus their accurate examination is very difficult, so that this and my own method are the only ones that can be used at all. It is of great importance to the tanner to know how his spent barks and liquors are running in strength. For the investigations the spent liquors were taken, treated with sulphuric acid, etc., as above, and the determination proceeded with as before. Five analyses were made of the spent liquors, direct from the vats, after a run with Buenos Ayres skins well cleansed and rinsed for the oak and hemlock. Liquors from sumac and catechu were taken—they had been used on fine skins, and were good samples. The results are tabulated in per cents.

No.	Oak.	Hemlock.	Sumac.	Catechu.
1	0·13%	0·08%	1·95%	1·90%
2	0·14%	0·085%	1·90%	1·925%
3	0·125%	0·88%	1·95%	1·93%
4	0·16%	0·08%	1·95%	1·89%
5	0·145%	0·085%	1·925%	1·90%
Average.	0·140%	0·08%	1·90%	1·91%
Real value.	0·27%	0·21%	1·02%	1·00%

These figures are of course only approximate, but lead proportionally to the real values, which are true to the first decimal. The causes of such great errors as these are that much less matter is separated with the tannate of gelatine. A very large proportion of this last dissolves the large proportion of gallic acid, etc., and the amount of free gelatine left in solution is greater in proportion with spent bark. The results are about the same, or a little higher, in comparison.

Now the prime argument: to show the misleading results given by this method, and to show the method used, we will consider the analysis of the hemlock bark decoction, keeping in our comparison the result obtained in No. 1. In the tables here we find the first value 7·25 per cent. tannic acid.

* Read before the American Chemical Society, April 7, 1882.

We take a cord of this bark, leach it, and obtain a measure (1,250 gals.) of decoction. The spent bark is examined by this method and found to contain 0·7 per cent. of tannic acid. Leather is carefully formed from the decoction, and what is 5 per cent. of the bark found to have combined, and as I will show further on, is now tannic acid. The spent liquors' value we find to be equal to 0·5 per cent. of the bark, that is to say, as we would speak of sweet liquors, nearly all the tannin in the bark, or 6·5 per cent. of it as tannic acid, treated in this manner so as to avoid confusion. All these figures together give a result of 6·2 per cent., or 1 per cent. unaccounted for, thus showing the first result to be too low also. The tannic in the spent liquors and forming them had been kept from change by the use of a preservative, and one which I know to be complete.

Now if the spent liquors be examined by my method we find it to contain what is equivalent to 1·4 per cent., which would bring the result up to 6·9 per cent.—still too low; but by also examining the spent bark by my method we obtain 1·5 instead of 0·5, and the figure is brought up to the actual point of 7·9 by this working test, or as we will see by consulting the table under my method, my result.

According to the reasoning deduced from the figures obtained by this method we would have 6 per cent. of the bark combined with the leather, but this is proven untrue every day in actual tanning, as over 5 per cent. for hemlock, others in proportion, is never attained.

The next method in order for consideration comes Hammel's process and its modifications, which were so popularly used some time ago, and even yet among the tanners. The results obtained by it in constant use were so inaccurate and inconstant as to have it speedily set aside, and one like Lowenthal's used. The many inaccuracies have been partially shown by a number of investigators, especially Proctor, who has shown that gallic acid is thrown down with the tannic acid, etc. The method was carefully tested and examined as the other, and the results are here tabulated.

No.	Hemlock.	Oak.	Chestnut	Nut Galls.	Sumac.	Catechu.	Kino.	Rhatany.
1	10·2	13·2	10·8	34·0	10·00			
2	6·5	6·4	0·8	43·0	11·00			
3	9·9	9·3	9·2	56·0	6·5			
4	11·4	12·4	7·4	40·0	7·6	Non-Accordant Results.		
5	9·6	14·0	6·9	61·0	9·8			
6	6·8	4·0	11·2	52·0	6·9			
7	11·2	8·0	10·2	57·0	8·2			
8	6·9	12·5	4·9	49·5	7·4			
9	8·4	5·0	8·6	45·0	10·5			
10	10·5	10·0	9·4	56·0	6·8			
Average.	9·14	9·48	8·26	49·0	8·57			
Real value.	7·90	8·22	7·42	61·5	16·25			

These figures were obtained in the following manner: The decoction, filtered and treated as before, was placed in a graduated jar, and the specific gravity taken by the use of a very delicate densimeter; the skin was then taken, thoroughly cleansed, bated, and raised by appropriate treatment; it was then thoroughly washed with a solution of gallic acid, and again with acetic acid, and finally with warm water until the liquors were pure and sweet; it was then placed in contact with the decoction, and allowed to tan in the first five analyses for an indefinite period, and in the last five for the shortest possible time without difference, however, these tannings being executed without access of air. It was then taken out and scrubbed off, and rolled as far as possible without altering the bulk of the solution, the specific gravity of which was then taken, the amount of tannic acid being calculated from the difference, etc.

The details of the method were executed with much more refinement than it is generally, and the principles involved thoroughly worked out; but with this observe the results. One might reason why should not the results be identical with the practical manufacture of the leather, or 5 per cent., etc.? This I can readily show. In the first place, to obtain the decoction for the determination, or, rather, to make solutions containing all the tannic acid from the material used, we have to extract much more extraneous matter, especially in the case with rhatany, kino, and catechu, than in the imperfect leaching of the tanneries, where, in the case of the last-named material, only 50 per cent. of the tannic acid is present, and a minimum of coloring matter is extracted; thus the leather has much less matter to contaminate with. In the second place, the sample of skin is never a fair specimen in the treatment of the whole skin, and more particularly, besides this, the leather formed cannot be properly freed from the different matters besides tannic acid held mechanically in the pores, without altering the volume of the solution, it must be remembered in this connection that leather, after it is formed, is thoroughly rolled, scrubbed, and treated in such a manner as to leave nothing but leather; the skin absorbs gallic acid, and the so-called extractive matters, even before the tannic acid and also by withdrawing the tannic and partly the gallic acids from the decoctions, much other matter is deposited, as I have shown before. Part of this is deposited in the leather, the rest is set free; this by the treatments noticed above is removed before the leather is dried and weighed. Thus in our determination much matter is abstracted and accounted for, as tannic acid thus yielding too high results. Besides these considerations the densimeter employed must have extreme delicacy, and even then a small distance on the scale represents much tannic acid, and the readings being so very different after the treatment, being influenced by the above condition. Altogether I pronounce this method little better than a mere guess—in fact, a tanner can arrive at closer results by his tasting the liquors than are obtained by this method.

In the examination of spent liquors and barks this method has no value at all, as it yields very inconstant results. This is caused mainly by the putrescent matters present in the liquor and the other causes intensified. In the analysis of the spent bark, the results are like those shown in the table below:

No.	Oak.	Hemlock.	Sumac	Catechu
1	6·5	4·0	7·9	4·0
2	2·2	5·2	8·4	3·0
Average,	4·3	4·8	8·2	3·5
Real value.	0·27	0·21	1·63	1·9

These results together are about the same as those obtained by the so-called tannometer; in fact Hammel's whole method, however modified, is about the same thing as this instrument, which I cannot too strongly emphasize should be done always within the tanneries, as it only shows how much tannic acid and otherwise, especially otherwise, may be held in solution.

In the use of this method, and the worthless modification of drying the skin fillings, and weighing before and after treatment, chemists and others generally obtain the results too low, but that depends upon the very nice point of understanding how to make leather. Like many other things, it is very simple to view, but requires considerable tact in that direction. Therefore the tanners, as a rule, obtain better results with it than chemists generally.

Using the calculations applied to Loewenthal's method for a control, we find thus: In the No. 1 as before, the leather, 5 per cent.; the spent liquor, 3·5 per cent.; the spent bark, 4·5 per cent.; these together, 13 per cent. This is quite far from the average value given, or 9·5 per cent. Now, giving the proper value to the spent liquor, or 1·4 per cent., the result is 10·9 per cent., or much nearer the truth—but showing the method to yield too high results, irrespective of any other method or control.

New York Laboratory, 319 Pearl st., N. Y.

(*To be continued.*)

COMETS.*

PART II.

By RICHARD A. PROCTOR.

FROM what we have already seen, it will be manifest that the formation of comets' tails is a process of a very marvelous nature, as apparently involving forces other than those with which we are acquainted. The tail, ninety millions of miles in length, which was seen stretching from the head of Newton's comet nearly along the path which the retreating comet had to traverse (the comet thus passing away with its tail in front, instead of behind, as when it approached the sun), must, it would seem, have been formed by some force far more active than the force of gravity. The distance traversed by the comet in the last four weeks of its approach to the sun under gravity was no greater than that over which the matter of the tail, seen after the comet had circled around the sun, had been carried in a few hours. Yet we have no other evidence of any repulsive force at all being exerted by the sun—at least, no evidence which can be regarded as demonstrative—and still less have we any evidence of a repulsive force exceeding in energy he sun's attracting power.

This difficulty, and the circumstance that a comet's tail lies in the direction opposite to the sun, or in the position which the shadow of the head would occupy, has led many, unfamiliar with the laws of optics, to suppose that the comet's tail may be simply the track of the luminous rays which have passed through the comet's head. They seem to think that the head may act in some way to send a beam of condensed light along the region opposite to the sun. It should hardly be necessary, however, to explain that no such beam of light could ever be seen where we see the comet's tail. The cases supposed to correspond with the formation in this way of the tail-like appendage are, in reality, of an entirely different kind. Thus, when we see a long beam extending from a bright light, we find that—first, the light has been caused to pass in that direction only (as when light is admitted into an otherwise darkened room through a hole); and secondly, there is matter along the course of the light to be illuminated. The beam is simply that long array of material particles which the light illuminates while leaving the particles in neighboring space in darkness. So understood, such a beam is seen to be utterly unlike a comet's tail; for, in the first place, we know of no matter behind the head to be illuminated; and, in the second, we know that light is falling on the regions all around the apparent array of illuminated particles, so that these surrounding regions should be as brightly lit up, which is not the case.

If any further doubt could remain as to this theory, it would be removed by—first, the circumstance that the tail of a comet is generally curved; and, secondly, the existence of several tails extending from the head of one and the same comet.

Professor Tyndall started a theory based on physical experiments, and otherwise in better accordance with scientific possibilities. Having found that certain gases, even in an exceedingly attenuated form, form a luminous cloud under the action of the electric light, he suggested that a comet's tail may be a luminous cloud of this sort, formed in the ether of space by those rays of sunlight which have passed through the comet's head. The rays which, without passing through the head, fall on the ether of space, would not call into existence this visible cloud, because their heating action would destroy what their chemical or actinic action *by itself* would produce. And as fast as, by the comet's motion, the cloud formed behind the head came under full solar action, it would be destroyed. So the tail would always be behind the head.

FIG. 6.—DONATI'S COMET, SEPTEMBER 24, 1858.

It appeared to Professor Tyndall that the curvature of a comet's tail, or the existence of more tails than one, as in Donati's comet (Figs. 6 and 7), was not inconsistent with this interpretation. For he noticed that according to the gas dealt with, the luminous cloud would take a longer or shorter time in becoming visible. And he suggested that when the cloud formed slowly, the tail would be curved, the part near the head being behind the position which the head had recently passed through, while the part near the end of the tail would be behind the regions through which the comet had passed much earlier. Such luminous trails as were formed more quickly would account, he considered, for the straighter tails. He overlooked, I think, the circumstance that the shape of the luminous cloud trail would not in reality depend at all upon the length of time which the cloud might take in becoming visible. Light would pass with the same velocity through the different kinds of

FIG. 7.—DONATI'S COMET, SEPTEMBER 26 1858.

*Continued from SUPPLEMENT No. 330, page 5270.

tenuous gas, and whether the cloud became visible at once along the space thus passed through, or did not become visible for several seconds, or minutes, or even hours, it would become visible at the farther end of its course only just so long after it had become visible at the nearer end, as light had taken in traversing the length of cloud so formed. This interval of time would be the same for the quickly appearing as for the slowly-appearing luminous cloud, and there would, therefore, be no difference between their forms. It would be necessary to account in this way for the curvature of the larger tail in the figure, as compared with the straightness of the smaller tails, that the curved tail should have been more slowly extended from the head; whereas the theory gives the same rate of extension for both, namely, the rate at which light travels.

We seem almost forced, by the phenomena of such a comet as Donati's, to the theory of the actual repulsion of matter from the head of the comet into the tails—matter repelled most swiftly forming the straighter tails, while matter repelled more slowly, and seemingly in greater abundance, forms the great curved tail.

surpassed by that of any other comet which has yet been observed." If its path had carried it nearer to the sun, its appearance would probably have been terrible in the extreme. If we consider the enormous volume occupied by this comet and its tail, its

Million cubic miles of head,
Ten billion leagues of tail,

we shall see that the phenomena we have to interpret ought not to escape us in virtue of minuteness of scale.

Next consider the great comet of 1861. This comet was discovered on May 13, by Mr John Tebbutt, Jr., of New South Wales, and first accurately observed at the Sydney Observatory, on May 26. It passed northward from the southern skies, and first became visible in Europe in the last week of June, 1861. The first recorded observations were made on the evening of June 30, nineteen days after it had passed its point of nearest approach to the sun. We remember well observing it on the morning of July 2, 1861. For some reason, we found it impossible to sleep that morning, and getting up about three in the morning (the exact hour

explained the peculiarity, and showed the necessity of taking into account the position of a comet before attaching undue importance to the apparent figure of its tail. For the fan-like form seen on this occasion was a mere effect of perspective. The end of the tail appeared very much wider than the part near the head—not that it really was so, but simply because it was very much nearer to the observer on earth. When we were actually immersed in the tail, the part nearest to us, being all round, had, to all intents and purposes, an infinite extension. But even when the comet was beyond that position, or a few days earlier, before it had reached it, the end of the tail was much nearer to us than the comet's head, and thus appeared far more proportionately widened than was actually the case.

Such considerations must always be taken into account in dealing with cometic phenomena. Comets more than any other celestial objects (the Milky Way, regarded as a whole, being, perhaps, alone excepted) are affected in shape, and apparently, even in their very nature, by position, and consequent fore-shortening.

Before considering the theory of repulsion as applied to

FIG. 8.—COMET OF 1811.

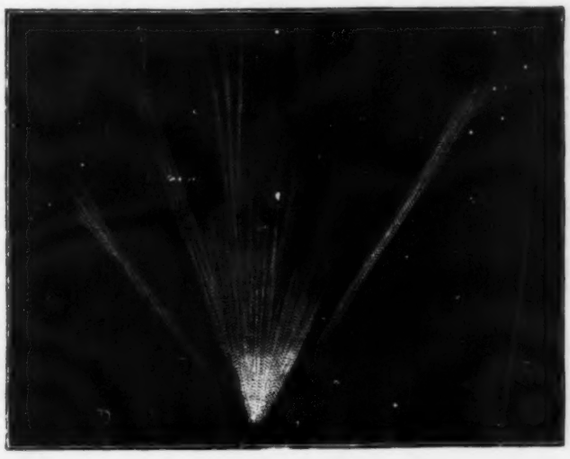


FIG. 9.

Before we proceed to consider the theory by which alone, so far as can be judged at present, the phenomena of comets' tails can be explained, it may be well that we should consider the evidence derived from other comets than those hitherto considered.

In the first place we would direct special attention to the comet of 1811. In this comet, as may be seen from its picture in Fig. 8, the various parts of the comet and its tail could be distinguished by the naked eye. There was the condensed part, called the *nucleus*, which in this case was apparently globular in form; the nebulous envelope which surrounds the nucleus, the so called *coma;* the bright side parts of the tail where it seems to be swept away from the coma, leaving a comparatively dark region behind the head, and the tail, widening and growing fainter with distance from the head. No one, we think, who considers this picture will for a moment imagine that the comet is a mere lens, and its tail merely the track of light condensed by this lens along the region behind the head. Here, again, the hollow structure of the tail seems indicated by the bright tracks on either side, though as we shall endeavor to show later, the

we do not remember, but it must have been very early), we saw in the east what looked at first like the rays of an aurora borealis. But presently we noticed that these rays proceeded (unlike those of the aurora) from a bright center, which had been hidden by clouds when our observations began. We used at that time to keep a four-inch telescope, mounted on a three-legged stand, in our bed-room. This we had quickly ready for action (noting that the object, owing to the approach of sunrise, was getting fainter every minute), and turning it on the comet, we drew a picture of the nucleus and coma so closely resembling that which appeared a week or two later in the *Illustrated London News*, that we might have supposed our picture had been surreptitiously sent to the office of the *Illustrated*, had we not found it resting just where we had put it in our scientific portfolio.

The comet appeared to the eye as shown in Fig. 9. Sir John Herschel, who observed it at Collingwood, in Kent, remarked that it was far more brilliant than any comet he had ever seen, not even excepting those of 1811 and 1858. The Padre Secchi, at Rome, found that in the clear skies of

interpret the phenomena of comets' tails, it may be well to consider a case in which some active force (other than gravity) exerted by the sun seems to have wrought the destruction of a comet, or, at least, to have broken up the comet into unrecognizable fragments.

No comet ever observed has exhibited phenomena more remarkable than those displayed by the comet known as Biela's (more properly called Gambart's). We wish we could agree with a modern astronomer, who has said that no comet has thrown more light on the nature of these bodies; but, in point of fact, it is only promise of light, not light itself, that we have obtained.

Discovered in 1826, Biela's comet was presently found to be identical with one seen in 1772 by Montaigne, and again by Pons in 1805. A careful study of the observations showed that the comet travels round the sun in a period of about 6¾ years, or, roughly, thrice in twenty years. Its path was found to approach very near to the path of our earth. The comet returned in 1832, when the ignorant were scared much as they have been recently by the threatened influence of the larger planets in perihelion. The comet crossed the

FIG. 10.—BIELA'S COMET IN 1846, BEFORE ITS DIVISION INTO TWO.

BIELA'S COMET ON JANUARY 15, AFTER ITS DIVISION INTO TWO.

exceedingly well defined nature of the dark track behind the nucleus in many comets seems to force upon us a different interpretation of this singular and characteristic feature.

In some respects the comet of 1811 tells us more of cometic possibilities, so to speak, than any other comet that has ever yet been observed. Discovered on March 26, 1811, this comet remained visible for a longer time than any yet seen, viz., for 16 months 22 days. It had a tail 120 millions of miles in length, and 15 millions of miles in diameter at the widest part. The diameter of the nucleus was about 127,000 miles, that of the envelope round the head about 643,000 miles. But what was so remarkable about this comet was, that it obtained this remarkable development without approaching the sun, as other comets have done. The usual rule with comets is that the nearer they approach to the sun, the more their heads and tails are developed. But the least distance of the comet of 1811 from the sun was little less than 100 millions of miles. Again, although it made so remarkable an appearance, as seen from the earth, the distance of that comet from us was at no time less than 110 millions of miles. Its true magnitude, therefore, as Professor Kirkwood well remarks, "has probably not been

Italy the tail was fully 118° in length, corresponding to nearly one-third more than the distance between the horizon and the point overhead. This comet, by the way, though only favorably visible for a very short time, remained within the range of telescopic vision much longer. Hind remarks that the number of separate observations for the determination of its orbit exceeds 1,150, and extend over a period of 11½ months. It traveled on a course favoring observation, coming from remote distances south of the plane in which the earth travels to the northern side of that plane—and as it chanced, crossing the plane (about five-sixths of the way from the sun to the earth's orbit) just when the earth lay in the same direction from the sun, so that for a time she was within the bounds of the comet's tail-like appendage—and then traveling northward on a path almost at right angles to the plane of the ecliptic. Thus the comet could be tracked on its retreat until, finally, distance concealed it from our view.

Now, the tail of the comet of 1861, as seen in Fig. 2, had something of the fan-like expansion observed in the tail of the comet of 1744; but what was known of the comet's position at the time when this fan-like form was seen,

earth's track several weeks before she herself came to the place where the two orbits approach nearest, and it is hardly necessary to say that the comet's passage did not injure the earth's roadway in any appreciable degree.

In 1839 the comet returned, but was not seen, traveling across a part of the heavens only above the horizon in the day-time, so that the comet's light was hidden by the sun's.

It was at the next return in 1845–46 that the comet first attracted special attention. On that occasion, instead of behaving as comets usually do, Biela's, which in the first days of 1846 had presented the appearance shown in Fig. 10, was found to have divided into two. There is some little doubt as to the time when the comet underwent division. Lieut. Maury reported on January 15 that he had seen the comet double on January 13; but Wichmann observed it as a single comet on the 16th. But Professor Challis, in his account of his own observations on the comets, states that even on January 15 the second comet might easily have been overlooked. M. Valz saw nothing unusual on the 18th and 20th; but on the 27th: "I was struck with amazement," he says, "to find two nebulosities, separated by an interval of two minutes of arc, instead of one nebulo-

sity alone. . . . Each head was followed by a short tail, whose direction was perpendicular to the line joining the two nebulosities. Earlier, only the larger comet had had a tail, the appearance presented by the double comet being that shown in Fig 11.

The two comets traveled along, side by side, until at last both passed out of view, at which time the distance between them amounted to about 157,000 miles.

In 1853 both comets returned. Sir John Herschel says, in his familiar "Lectures on Scientific Subjects," that when they returned, the distance between them was unchanged. This, however, was a mistake. The distance now amounted to about 1¼ millions of miles. Again they passed before the interested gaze of astronomers, traveling side by side, though rather far apart, until finally they disappeared from view—we say finally, for neither has ever been seen again.

Whether the two comets returned in 1859 is doubtful. It is certain that if they did, they would have been invisible, for the same reason that the comet was invisible when it returned in 1839.

But in 1866 the double comet should have been well seen. It should be remembered that each return of a comet of short period (like that which our correspondent, Mr. F. Denning, of Bristol, discovered this year) gives the astronomer more perfect mastery of the comet's motions. The return could be predicted with sufficient accuracy in 1852 to cause the comet to be easily redetected. The next visible return might have involved a difficulty, because the comet had in the interval made two circuits. But that return was successfully predicted. The return in 1845-46 was still more accurately calculated. Nor did the breaking up of the comet into two on that occasion interfere with the successful calculation of the return in 1852. The case may be compared to the rating of a clock, which is more satisfactorily effected in a week than in a day, for the simple reason that any error of observation is spread in one case over seven times as long a period as in the other, and therefore affects the estimate of any given circuit of the hands by an error only one-seventh as large. Just so, whatever error an astronomer might make in observing Biela's comet in, say, 1843, was distributed over all the revolutions of the comet which had taken place since 1826 (one might almost say since 1772), and in a correspondingly small degree affected the astronomer's estimates of the comet's motion during any single revolution. This being so, astronomers had good reason for believing that in 1866 Biela's comet would return. When the time came that it should have been visible, telescopes were turned toward the spot where it should have been seen. Night after night from that time its calculated track was swept with the finest telescopes in Europe and America. But no trace of the comet could be seen. "It is now," wrote Sir John Herschel in February, 1836, "overdue. Its orbit has been recomputed, and an ephemeris calculated. Astronomers have been eagerly looking out for its reappearance for the last two months, when, according to all former experience, it ought to have been conspicuously visible, but without success! giving rise to the strangest surmises. At all events, it seems to have fairly disappeared, and that without any such excuse as in the case of Lexell's—the preponderant attraction of some great planet. Can it have come into contact, or exceedingly close approach to some asteroid as yet undiscovered; or, peradventure, plunged into and got bewildered among the ring of meteorolites, which astronomers more than suspect?"

Be the cause what it might, the comet was not seen in 1866. In 1872 it was looked for even more carefully. Every possible contingency depending on planetary perturbations was considered; and the telescopes of astronomers swept, not only the calculated path, but to a considerable distance on either side of it. No trace of the comet was seen, however, in 1872 any more than in 1866. So far as telescopic observation is concerned, Biela's comet seems to have come to the end of its career as a comet.

Yet the observations of 1852 were not the last which were made on this interesting subject. It has been seen again, though not as a comet. Nay, the occasion on which it was seen in the way referred to was predicted, and the prediction fulfilled, even in details. We shall return to the consideration of this remarkable apparition of the comet in changed form—a form which but a quarter of a century ago no one would have thought of associating in any way with the long-tailed star whose approach had been regarded as heralding some great change in the fortunes of men and nations.—*Knowledge.*

THE DAILY PRESS OF 1880.

FROM 2,526 journals of all classes published in the United States in 1850, with a circulation of 5,142,177 copies each issue, the press status advanced in 1880 to 11,403 journals, with 31,177,924 copies per issue. Of these 254 were dailies in 1850, with 758,454 copies, and in 1880 980 were dailies with 3,637,424 copies. The six leading States in regard to number and circulation of dailies were New York, 116, with an aggregate daily circulation of 990,048; Pennsylvania, 100, with a circulation of 598,627; Illinois, 75, circulation, 270,183; Massachusetts, 39, circulation, 280,369; Ohio, 56, circulation, 215,934; California, 59, circulation, 178,864. The total amounts paid annually in wages by daily journals and all others in 1880 was $28,571,336.38, and the total value of the product of the dailies was $42,750,034.03. New York journals of all classes paid in wages $6,460,071, and the value of the product of dailies was $10,412,990.52; Pennsylvania, wages, $2,913,162, daily product, $4,841 396; Illinois, wages, $2,736,717.42, product, $3,451,156.92; Massachusetts, wages, $2,074,749, product, $3,033,266; Ohio, wages, $1,761,038 product, $3,182,295; California, wages, $1,300,139.86, product, $2,587,157.64. These figures place Illinois the third State in the number of daily journals, and the fourth in regard to circulation per issue. Massachusetts leading her slightly in this respect, though Illinois pays about $700,000 more in wages, and her daily papers produce over $300,000 more than those of Massachusetts. The Northwestern States published 310 dailies, with an aggregate circulation in 1880 of 242 391,924, or 770,620 each issue; ten Pacific States and Territories published 125 dailies, with an aggregate circulation, in 1880, of 84,474,644, or 253,112 each issue; three Middle States published 243 dailies, with an aggregate circulation of 519,331,761, or 1,648,551 copies each issue; 17 Southern States, with 211 dailies, having an aggregate circulation in 1880 of 199,339,829, or a circulation each issue of 561,710; six New England States, with an aggregate circulation of 123,335,612 in 1880, or a circulation each issue of 187,821.

By these figures it appears that the six States of New England and the three States of New York, New Jersey, and Pennsylvania combined published about one third of the daily newspapers, the circulation of which aggregate more than one-half of the entire issues of the daily press of the country. The 10 Northwestern States, the 10 Pacific States, and the 17 Southern States published, in 1880, 646 dailies, with aggregate circulations for that year of 5:6,209,897. The press of the West and South, however, is growing more rapidly than that of New England and the Middle States, and every future year will increase the relative importance of the journalism of those sections to which the great currents of emigration are flowing.

Mr. S. D. North, who compiled the press statistics for the late census, has deduced some curious facts respecting the growth of daily journalism. The 980 daily newspapers published in 1880, were published in 388 towns—an average of two and a-half to a town. In some towns with less than 4,000 population, two and sometimes three dailies are regularly published. The smallest town which supported a daily was Weldon, N. C., with a population of 932; Toombstone, Arizona, with 973 people, had two dailies; Eureka, Cal., with 2,639 inhabitants, had three dailies; Galena, Kansas, 1,463, two dailies. Contrast our 980 dailies with the 166 daily journals of Great Britain in 1881, the average circulation of the latter, it should be said, is 19,710, while the American average is but 3,971. The London Daily *Telegraph* sells every day more than double the largest average sold by any American newspaper. The press of Great Britain is almost a complete monopoly; but it has the advantage of stability. Of journals started in the United States during the census year there were 1,120, and 905 suspended publication during the same time. A census table shows 350 daily or weekly journals which have been published regularly for fifty years or longer. In Kansas City five daily papers were published for a population of 55 813, while the 29 dailies in New York had an aggregate circulation per issue of 765,000 in 1880, showing the tendency toward the increase in circulation of the papers already in existence. This fact is observable in the history of nearly all of our large cities. When New York had a population half of that at present, it had more daily papers than are now published in the city. The same is true of Chicago, whose dailies have decreased in number with its increase in population.

Among the daily journals of the country, only 124 were found with a circulation of less than 500, and there were 282 with a circulation between 1,000 and 3,000; there were 260 with a circulation of 3,000 over, and 105 had a circulation between 3,000 and 5,000. Mr. North discovered that the greater number of dailies whose circulation is placed at between 1,000 and 2,000 are profitable pieces of property on a limited scale, and that this class of journals is measurably independent, and represents the bone and sinew of American journalism.

Coming down to the relative circulation of the dailies of the larger cities, it is shown that the average number of inhabitants to each daily paper printed in twenty-six principal cities, taken together, was 406; and accepting this average for any city of 50,000, the aggregate circulation of all its daily papers would be but 12,310. The following table shows the eleven cities which stood first in the ratio of circulation to population:

Cities.	No. of dailies.	Circulation.	Population.	No. of people to each copy.
Pittsburg	11	111,001	156,381	1·41
New York	29	765,743	1,206,590	1·57
San Francisco	22	143,232	233,956	1·63
Boston	11	221,315	362,535	1·64
Springfield	3	18,464	33 350	1·81
St. Paul	6	19,893	41,498	2·09
Indianapolis	4	35,587	75,074	2·11
Cincinnati	11	117,549	255,708	2·18
Chicago	18	220,577	503 304	2·28
Philadelphia	24	363,286	846,984	2·33
Baltimore	9	128 643	332 190	2·58

The total gross value of the product of the newspaper and periodical press of the country during 1880 was $87,441,132.22, of which the daily journals produced $42,750,034.03, or nearly one-half of the entire aggregate, while the amount paid in wages on all descriptions of journals was $28,571,336.38, or nearly one-third of the entire gross product. The weight of paper used for all the issues of the press is estimated at 178,165,951 pounds, and its value $14,253,276.08, or 16·3 per cent. of the gross product. This sum added to the wages paid, would reach $42,824 612.46, leaving the sum of $44,516,519.76 to represent other necessary expenses, such as ink, telegraph news, rent, repairs, increase of plant, etc., and the surplus of profits earned. It is estimated that 46·21 per cent. of the gross income was derived from subscriptions or sales of papers, and 53·79 per cent. from advertising. There were employed 54,654 persons in the mechanical department, etc., and 16,489 in the editorial capacity.

PHOSPHORESCENT ROCK.

AT a recent meeting of the San Francisco Microscopical Society, Mr. H. G. Hanks, State Mineralogist, read the following paper:

Some time since, D. B. Huntley, of the Geological Corps of the Tenth Census of the United States, brought to the State Mining Bureau a mineral, with the statement that it had shown certain peculiarities which led the miners to call it by the rather startling name of "Hell-fire rock."

The property known to mineralogists as phosphorescence is not confined to one mineral species, nor is it very uncommon. But in this specimen it is so strongly marked that there is some excuse for the refusal on the part of some of the miners to work in the mine. When striking their picks into this formation, flashes of light were seen, which they regarded with superstitious alarm.

The locality in detail is Shenandoah mine, Snake Creek district, Wasatch county, Utah.

A chemical examination shows this mineral to be an impure dolomite. It is interesting, not only from its remarkable phosphorescence when rubbed with any hard substance in the dark, but from its beautiful crystalline appearance under the microscope, and the ease with which it can be reduced to a crystalline powder, even by crushing between the fingers.

In "Cleveland's Mineralogy" we find it stated that some varieties of dolomite are phosphorescent in the dark, either by friction or when thrown on a shovel which has been allowed to cool just below the point of redness.

The lights being turned down, Mr. Hanks produced the phosphorescence beautifully by scratching the specimen with a knife blade. It was of a bright reddish-yellow or orange color, and it was clearly seen how a miner could be agitated by striking such infernal material in his subterranean walks.

MOTILITY IN THE FLOWERS OF DRABA VERNA.

As is well known this plant flowers during any open time in spring, say from February to June, with us. In the early part of the season the petals expand about 9 A.M., and close about 2 P.M. Surprised that I had not noticed this opening and closing years before, I was led to observe it from day to day, and many times a day. If there was the least cloudiness, no matter how great the volume of light, the petals would not expand. During nearly a week of cloudiness no flowers expanded. On the least burst of sunlight, however, the flowers opened, provided always it was before 2 P.M. I felt little hesitation in deciding that sunlight was the immediate agency in expansion. One day we had a heavy thunder shower. The next day was wholly cloudy; but, strange to say, they expanded during this warm, moist cloudy day, as well as under the previous sunlight! They seem to expand every day since, sunlight or not; through all these variations, however, up to to-day they close regularly about two o'clock. To my mind it leaves the cause of motion more obscure than ever. It is evidently not light alone, and it is a gain to know what it is not. Yet if we had reflected we might have learned this lesson before, for there are some flowers opening at every hour of the twenty-four. Under the same light, when one expands another may be closing; what is one man's meat is another one's poison. It is not the food, but the internal arrangements—it is not the light, but the ability to make use of it.—*T. Meehan.*

MR. C. H. BOYD records the discovery of the remains of a walrus near Addison Point, Washington County, Me., in a bed of blue clay two feet above high water mark. A few years ago a nearly perfect skeleton was found in the marine clays at Portland, Me.

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